Prehistoric Society of East Anglia.

REPORT

ON THE

EXCAVATIONS

AT

GRIME'S GRAVES, WEETING,

NORFOLK.

MARCH—MAY, 1914.

(WITH 30 PLATES AND 86 FIGURES.)

Price 5/- Nett. (Postage 4d.)

LONDON:
H. K. LEWIS, 136, GOWER STREET, W.C.
1915.

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EDITED BY W. G. CLARKE, HON. SEC.

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The Prehistoric Society of East Anglia.

(Corresponding Society of the British Association).

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The President, Vice-President, Hon. Treasurer, Hon. Secretary, Dr. W. Allen Sturge, M.V.O., F. Leney, and H. J. Thouless.

INTRODUCTION.

At the Fifth Annual Meeting of the Prehistoric Society of East Anglia at Norwich Castle Museum on October 13th, 1913, the Hon. Secretary (Mr. W. G. Clarke) reported that the desirability of conducting excavations at Grime's Graves, Weeting, had been suggested to him, and in order to ascertain if permission would be granted he had written to the Trustees of the Weeting Estate (Mrs. T. S. Hall and Mr. C. Cockburn) and had received permission for excavations to be carried out between January 1st and June 1st, 1914, with the stipulation that the trustees should be consulted as to the disposal to public institutions of any articles of interest which might be found. The project was received with enthusiasm, and the Hon. Secretary was authorised to issue an appeal for funds. This was issued in due course and signed by Mr. J. Reid Moir, F.R.A.I. (President), Sir E. Ray Lankester, K.C.B., F.R.S. (Vice-President), and Dr. W. Allen Sturge, M.V.O., F.R.C.S. (ex-President).

At a meeting of the Society on December 8th, 1913, the Hon. Secretary reported that the sum of £118 had been subscribed. The following were elected a Committee to superintend the excavations:—The Rev. H. J. Dukinfield Astley, M.A., Litt. D., Mr. F. Canton, M.R.C.S., L.R.C.P., L.D.S., L.S.A., Mr. W. G. Clarke, Mr. H. H. Halls, Mr. J. Reid Moir, F.R.A.I., Mr. A. E. Peake, M.R.C.S., L.R.C.P., Mr. Reginald Smith, F.S.A., and Mr. S. Hazzledine Warren, F.G.S. The death of Mr. Canton a few days later prevented him taking any part in the work.

A further sum of £30 had been subscribed before January 26th, 1914, when it was reported that Dr. A. E. Peake, of Gorse Bank, Peppard Common, Henley-on-Thames, had consented to take charge of the excavations, assisted each week by a member of the Society. A number of experts had also agreed to report on any "finds" which might be made.

On Saturday, January 31st, 1914, Mr. J. Reid Moir, Dr. A. E. Peake, Mr. W. G. Clarke, Mr. S. J. Adcock (sub-agent for the Estate), Mr. J. Holder Wilkinson, and Mr. A. Holden, of Thetford (the contractor), met at Grime's Graves to select a pit for excavation. The one chosen was in the north-west portion of the area, as remote as possible from the one excavated by Canon Greenwell. It had an apparent diameter at the mouth of between 20 and 30 feet, was rather shallow, easy of access for the workmen, and surrounded by other shafts.

The work on Pit I. was begun on March 2nd, 1914, and finished on April 4th, and that on Pit II. was begun on April 4th and finished on May 9th, though Dr. Peake remained until May 22nd to undertake the packing and despatch of the "finds."

The selection of Pit II. was made by Mr. Reid Moir, Dr. Peake, Mr. Reginald Smith, and Mr. W. G. Clarke. By arrangement with the Weeting Estate authorities, permits to view the excavations were granted only by the Hon. Secretary of the Prehistoric Society of East Anglia, and archæologists from far and near availed themselves of the opportunity of seeing the work in progress and of inspecting a prehistoric flint-mining shaft.

Thanks are due and are cordially tendered to the Trustees of the Weeting Estate for permission to excavate at Grime's Graves, and for providing the wood to fence the two shafts opened; to Colonel E. P. Mackenzie, Mr. R. Meade, and Mr. P. Harding for allowing the temporary use of a footpath across part of the Santon Estate; to the Weeting Estate Agent (Mr. Charles Cockburn), and the Sub-Agent (Mr. S. J. Adcock) for granting every facility for the progress of the work; to Dr. A. E. Peake for taking sole charge of the excavation; to Mr. J. Reid Moir, F.R.A.I., Mr. Reginald A. Smith, F.S.A., Mr. A. Leslie Armstrong, F.S.A. (Scot.), Mr. and Mrs. E. T. Lingwood, Mr. A. Mayfield, M.C.S., the Rev. A. Cross, Mr. B. P. Allinson, Mr. E. St. Hilary Lingwood, and Mr. Wykeham Sharman for invaluable assistance during the course of the excavations; to Captain Harold Hall, Lieutenant Walter Hall, Second-Lieutenant Athelstan Hall, and Mr. D. Casey for much practical help; to Mr. A. S. Kennard, F.G.S., for selecting and despatching the Mollusca to various Museums; to Mr. J. W. Clarke for providing several months' storage for much of the material found; to Mr. H. Dixon Hewitt, F.I.C., for helping in the measurement of the antler-picks; to Mr. W. H. Burrell, F.L.S., for reading one set of proofs; and to those who have examined the specimens and whose descriptions appear in this Report.

Special thanks are due to Dr. W. Allen Sturge, M.V.O., for his hospitality not only to members of the Committee, but also to the flints, which were arranged and allocated to various subscribing museums at Icklingham Hall. His own splendid collection was as usual placed at our disposal, and many interesting parallels have been noted in the description of the flints. The assistance thus given was all the more welcome as a visit to French museums for the purpose of this report would have been impossible in present circumstances.

GRIME'S GRAVES FUND.

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S. Hazzledine Warren, F.G.S. (Loughton)		10	6
J. H. Wilkinson (Lynford)		5	0
Borough of Worthing Museum	3	3	0
Total	£225	5	6

[The Balance Sheet will be found at the end of the Report.]

The Grime's Graves Excavations, 1914.

By A. E. Peake, M.R.C.S., L.R.C.P.

INTRODUCTION.

In the following account the work carried on in 1914 is split up into various sections. It is hoped by adopting this method to make the account clearer than if all the details were compressed into a single narrative.

In order to throw light on various points, a short account of different mining sites in this country and abroad precedes the report of the actual excavations. I think this will not be without value to a student of prehistoric work and of Grime's Graves in particular. The following order is adopted:—A short history of Grime's Graves and the association of "Grim" in other parts of the country; the previous recorded work on the site, including that of the Revs. S. T. Pettigrew and C. R. Manning, and of Canon Greenwell; and the mining at Spiennes, in Belgium, which presents many close parallels with Grime's Graves. Following this is a short account of the mines at Obourg, Champignolles, and Mur de Barrez. Some points of comparison are then given with Cissbury—the best known English flint mine—and a few other sites, and reference made to Mr. Reginald Smith's paper on "Cissbury" and "Grime's Graves." The problems are then enunciated, and a general description of the Graves follows, with the methods employed in the present work.

The two shafts excavated are dealt with separately in the following order:—

(*a*) The actual digging given in sequence.
(*b*) Detailed account of the layers and their contents, including a special account of the human remains.
(*c*) The empty pit is described, and an interpretation of the layers given.
(*d*) An account of the first appearance of the galleries.
(*e*) A general account of the mine which can be followed by reference to the plan, and the way in which the mine was worked.
(*f*) The red deer horns found in the shafts and galleries.
(*g*) The fauna, with some general remarks.

Under Pit I. is given a record of the time taken in excavation, and a rough estimate of the amount of material taken out by the miners from the shaft and one of the galleries. A comparison is then drawn between the three shafts, including that excavated in 1870, with a view to ascertaining if there is any difference in date. Detailed accounts follow of the floors, the tumulus, and the various sections. Some remarks are then made on the patina of the chipped pieces, and the evidence of the use of a polished axe is summed up.

As the above account is only a portion of the whole evidence no attempt is made to assign a date to the industry.

GRIME AND HIS ASSOCIATIONS: HISTORY OF GRIME'S GRAVES.

In seeking to solve the mystery of the date of Grime's Graves one naturally turns first to the name. Tradition, though frequently untrustworthy, sometimes gives a clue to the nature of a monument. The various invasions of our island seem to have cut off any knowledge of most of the prehistoric monuments; and the absence of a tradition attached to this site is testimony to its extreme antiquity. It is somewhat singular it has not been connected in some way with the mysterious rites of the Druids, and this is all the more surprising as the learned Dr. Stukeley apparently knew of its existence.

It is well, however, to examine the name and see how it became attached to the spot. It is certain as a result of the exploration of the tumulus, that a great chief, or someone of importance, was buried there, and it is equally certain that whoever this chief was his body was burnt after the mining had started on this spot. (*See* Tumulus). Canon Greenwell suggested that a Scandinavian named Grim might have possessed the land; and that the Hundred of Grimshoe in which the Graves are situated took its name in this way, and that afterwards the hollows received the name of Grime's Graves (for graves has not the significance we attach to it, but denotes merely pits or hollows).

That the area may have taken its name in this way is borne out by the legend associated with Grimsby. On the borough seal of this place, which is of 14th Century date, reference is made to the curious legend told in the Anglo-Saxon poem of Havlok the Dane. In this legend a man, who proved to be the son of a powerful Danish Chief, was rescued from drowning by a fisherman named Grim. News of this was sent by Havlok (the Sea waif) to his father, who in gratitude conferred upon the humble fisherman the position of lord of the port, which carried with it many Danish privileges.

The mound, however, is not the only one near the Graves, as two others lie just outside the boundary to the south. Seven, too, in the immediate neighbourhood were opened by Lord Rosehill about the year 1870.

The name of Grime is applied to a great number of earthworks scattered about the whole of England, and with the exception of Grimsby there is no tradition to account for the name. Grim is a Norse word, meaning a witch or watersprite, and figures as the name of a deity in the Norse mythology. Whatever the origin of the name the Saxons appear to have applied it to anything mysterious and without a history, and consequently it crops up in various parts of the country, applied indiscriminately to dykes, banks, and camps. They gave the name of Grim's Dyke to the wall of Antoninus, which stretched from the Forth to the Clyde, though the true nature of the work must have been made known to them by Romanised Britons. The same name occurs in Hertfordshire and Yorkshire, in Wilts

near Salisbury, and near London in the parishes of Pinner and Harrow. In Oxfordshire a Grymes dyke or bank is traceable from the Thames between Newnham and Mongwell, coming from Speen near Newbury by way of Lockinge, Churn, and Cholsey, in a wavy but not quite continuous line as far as the outskirts of Henley-on-Thames, beyond which it can be traced to Colnbrook and Colchester. At Speen is a circular entrenchment known as Grimsbury Castle. On Dartmoor in Langcombe Bottom is a Grymes Grove (mentioned in the Perambulation of 1240) containing a fine kistvaen surrounded by an imperfect circle. John Page ("Exploration of Dartmoor") suggests the name stands for Grim's Grave, and marks the tomb of a viking who fell in battle. Grimspound, too, is in the same county, and consists of a walled enclosure containing 30 huts, whilst close at hand are Grimslake and Grim Pyndan (the boundary pound). In Cheshire a Grimsditch is found, and in Norfolk, Grimston. The latter word occurs as a surname in Lancashire. Messrs. W. G. Clarke and H. Dixon Hewitt in their account of the Drove Road (Proceedings P. Soc. E. A., Vol. I, p. 430) mention Grimmer's Breck, the name of a field four miles from Thetford. The words Grimes and Grimmer are Scandinavian personal names, and are still not uncommon in Norfolk, both as Christian name and surname.

It is clear that Grim was known over a wide area of England, as in Lancashire we find Grimley and Grimshead; and in Hants, Grimstead and a Grimespitte, and the surnames Grimston, Grymstead, and Grimshaw. In Dorsetshire is another Grimstone, and in Warwickshire is Grimshaw Hall. There are also Grimsthorpe Castle and Grimoldby in Lincolnshire.

In the medical profession in England one finds the surnames Grime, Grimes, Grimmer, Grimsdale, Grimswade, Grimwade, Grimshaw, and Grimoldby, but no name with the prefix Grim occurs in Wales, Ireland, or Scotland, though there is a Graeme's Dyke in the south part of the last named. In Hants the Abbot of Newminster was St. Grimbald.

All of these place names and surnames are no doubt derived from some spot in which the Saxons found an earthwork whose origin they did not know. It is supposed that the names of various dykes, etc., ascribed to his satanic majesty have the same origin. Ex. Devil's Dyke near Brighton.

From the fact that Grime's Graves lie in the Grimshoe Hundred, this area would seem to have been held in greater importance by the Saxons than most of those mentioned above. It may be assumed then that between the 6th and 9th Centuries there were no existing traditions of any value as to the origin of these prehistoric earthworks, and it seems quite clear that at that date the true nature of the work carried on was not known. The earliest mention of the "Graves" is in Camden's Britannia, 1586. The author says: "At a mile's distance eastward (of Weeting) is a hill with certain small trenches or ancient fortifications called Gime's (?) Graves, of which name the inhabitants can give no account" (p. 402, 1695 edition).

Mr. W. G. Clarke, writing in the *Norwich Mercury* "Secrets of Prehistoric Man: History and Mystery of Grime's Graves" (Dec. 6th, 1913), tells us:—"Early maps give so little detail that it is apparently not until 1824 that Grime's Graves appear on a map of Norfolk. They are not marked on fairly detailed maps of 1797, 1803, and 1811. On the Ordnance Map of 1824, issued by Major Colby, the plantation in which 'Grime's Graves' are situated is marked, but the name is applied to some hollows a mile to the south-west at what is now known as Botany Bay, Weeting. In Bryant's Map (1826) they are correctly placed and named 'Grimmers Graves,' but in Greenwood's (1831-2) 'Grime's Graves' is used, and has apparently since been retained by map-makers, though many country people still know them as 'Grimmer's Graves.'

"References to 'Grime's Graves' before 1870 have a value as showing the ideas then prevalent, but are archæologically inaccurate. Dealing with the Hundred of Grimshoe, in his 'History of Norfolk' (1739), the Rev. Francis Blomefield says (p. 148) that: 'About the centre of this hundred, two miles east of *Weeting*, in the road from *Brandon* to *Norwich*, is a very curious *Danish* incampment, in a semi-circular form, consisting of about twelve acres, on the side of a hill or rising ground of marl or chalk. In this space are great numbers of large, deep pits, joined in a regular manner, one near to another, in form of a *quincunx*, the largest seeming to be in the centre, where probably the general's or commander's tent was. These pits are dug so deep, and are so numerous, that they are capable not only of receiving a very great army, but also of covering and concealing them in such a manner that travellers passing by cannot discern them; at the east end of this entrenchment (called by the neighbourhood the *Holes*), is a large *tumulus*, pointing towards *Thetford* (about five or six miles distant), which perhaps might also have served as a watch tower or a place of signal; and here the *hundred court* used to be called. This remarkable place retains also the name of *Grimes-Graves*, as well as that of *the Holes*, taking its name from the aforesaid *Grime*, and from the *Islandick*, or old *Danish* word *grafa*, *fodere*, to dig.'

"Blomefield's views appear to have been accepted without hesitation for over a century, but on March 4th, 1852, the Rev. C. R. Manning reported to the Norfolk and Norwich Archæological Society 'the result of an examination he had made of the large collection of pits on the heath at Weeting, near Brandon, commonly known as 'Grimmers' or 'Grimes Graves.' This examination appeared fully to confirm the opinion that they were the remains of a British village.'† At a meeting of the British Archæological Association on February 25th, 1852, the Rev. S. T. Pettigrew stated * that he had 'opened two of the Graves and found in each some bones of animals appearing to belong to the ox and the pig. The place was formerly the seat of war between the Saxons and

† Norfolk Archæology, Vol. IV., p. 356.
* Jour. of the Brit. Arch. Assn., Vol. VIII., p. 77.

the Danes. No other remains beyond those of the bones laid in a bed of flint stones were discovered. These were in a cavity of a coffin-like shape.' "

At an excursion of the Norfolk and Norwich Archæological Society to Grime's Graves on July 5th, 1866, the Rev. C. R. Manning, M.A., read a paper on a place which he described as "one of the most curious in the county, and even in the kingdom," and he unhesitatingly described the Graves as a collection of British dwellings—the home of the Iceni. The wood, he stated, was planted about 1816, and at that time the pits were partially filled up by throwing earth into them, the accumulation of debris being about 18 ins. in depth. "It is very clear," he proceeds, "from their careful construction, paving, and fireplaces, that they were intended for permanent habitation." "In February, 1852," he adds, "I obtained permission to examine some of the pits in 'Grime's Graves'—a trench was dug through several of them, and in each case, about three feet below the lowest point at the bottom, we came upon a small oval wall of flints, evidently a fireplace, containing numerous bones of oxen, but no implements. By the kind permission of Mr. Angerstein, excavations have again been made this week, for our inspection to-day, and with the same result, although in the pits now opened the fireplaces are not so distinctly preserved." He also gives a record of the first chipped implement found at the "Graves." "A flint worked for a celt was found in the wood at Grime's Graves by Mr. Prigg, of Bury, during the visit of the Society." Finally, he refers to "The Ride" which runs from the south-west corner of the wood, and speculates whether the mounds near the south border of the plantation were for the protection of the "Graves."

PREVIOUS WORK AT GRIME'S GRAVES.

The only work of excavation on this site of which we have any record seems to be the opening of two of the pits in 1852 by the Rev. S. T. Pettigrew, and several in the same year and in 1866 by the Rev. C. R. Manning, but in each case only a few feet of soil was removed. The Rev. Francis Blomefield does not seem to have carried out any practical work. The record is interesting as showing that a number of pits were used at some period as dwelling spots. Mr. Manning mentions that the fireplaces found during his work were only 3 ft. below the centre of the pit. This would correspond with that found in Section 7, and the absence of implements points to a similar date. The ornamented pottery found in the former site should be dateable, and it may be assumed from the presence of "young" animals that the area was not at that time a sandy waste. It is certain that in the work mentioned above, the living level represented by the black band in Pits 1 and 2 was not reached as these were 10 ft. and 9 ft. respectively below the surface.

The only previous exhaustive work at Grime's Graves was carried out by the Rev. Wm. Greenwell, M.A., F.S.A., and described in the Journal of the Ethnological Society of London, January, 1871, in a paper entitled "On the opening of Grime's Graves in Norfolk." He was assisted by Lord Rosehill, who read a paper on the work, in 1870, to the Society of Antiquaries of Scotland, in whose Proceedings it appeared. As this work epitomised our knowledge of mining on this site up to that date, and formed a guide to the present work, a *resumé* of the results is given here.

Canon Greenwell states "the Graves are situated in a wood sloping slightly to the north, in number about 254, lying about 25 ft. apart, of circular form, with a diameter of 20–65 ft., and an average present depth of 4 ft. The area covered is 20–21 acres. In several cases the pits run together and form irregular-shaped hollows. This is probably caused by the falling-in of the roof of the galleries." (*See* Section 9.) In speaking of the tumulus he says, "It appears to be nothing more than a heap of the material taken out of one of the pits, possibly from the first that was opened, and when there was no other way of disposing of it, there being no existing excavation into which to throw it. Round the pits is a mound formed of material thrown out by the miners."

The pit opened was on the east side of the series, near the extreme edge, and almost in the S.E. angle. It was rather under the medium size, being 28 ft. in diameter at the mouth, and gradually narrowing to a width of 12 ft. at the bottom which was 39–40 ft. from the surface. It was cut through a deposit of dark yellow sand 13 ft. in thickness, here overlying the chalk upon which lay nodules of flint unsuitable for the making of implements. Nodules were also found in the upper part of the chalk wall of the shaft. It was filled up "gradually" with chalk and sand taken out of other pits, the shaft remaining open at different levels for a considerable time during which it was the receptacle of refuse. He expressed surprise that more was not found in consequence, and surmised either that the people were not possessed of many implements and utensils, or this pit happened to be poor in them. No pottery came to light, but the Canon remarks "it is impossible to believe these people were ignorant of its use." In describing the infilling of the pit, no section of which was published, he says "it was impossible to make out any layers." "In many cases a mass of chalk rubble at the centre did not extend as far as the sides of the pit, whilst in others it only reached from the side to near the middle." (This is precisely the appearance a series of "tips" would present as it was cut through. The mass of chalk in the centre being the bottom of one such tip, and that at the side the top of one at a lower level). The lowest 18 ft. consisted of chalk only which came from between two beds of flint, and above this was a considerable thickness of sand. The rest was made up of chalk rubble, sand, and nodules, and flakes of flint. By using the pits for the newly excavated material the neighbouring surface was left free for the sinking of other shafts. "Scattered indiscriminately

through the whole of the material were numerous bones of animals (mostly broken to extract the marrow), charcoal, burnt sand, chippings and cores of flint, pebbles and quartzite hammers for flaking, tools of deer's horn, and other articles." In regard to the bones this statement was subsequently modified, as they were found in the space between 4 and 28 ft. from the surface (showing that the pit must have been filled nearly to the margin when the work commenced). The bones were identified by Prof. Boyd Dawkins and proved to be small ox, probably *Bos longifrons*, the most numerous—next to these sheep or goat; then horse and pig; and only two bones of red deer. The ox bones included many calves, and from this fact it was concluded that milk formed part of the diet. Dog was also included, and several were too old for hunting and had apparently been killed for food. Roedeer is not in the list, but an implement is mentioned made from a bone of this animal.

At a depth of 28 ft. a hearth of calcined flints was found near the east edge of the pit, made up of a mass of charcoal 4 ft. by 5 ft. This would be amongst the chalk blocks as these extended for 18 ft. above the bottom of the shaft, and it would seem that the ladder (if one was used) was still in the pit at that time though the galleries were no longer being worked. In describing the method of excavation the writer states that "The ancient workers sunk a circular shaft gradually decreasing in size to the level of the stratum of the best flint, passing through the upper layer of the so-called wall stone at 19½ ft. below the top of the chalk, but not removing any of that bed beyond what occurred within the limits of the shaft itself." This layer (which is used for building) was used to a considerable extent by the people for making the smaller and coarser kinds of implements, as chipped cores, etc., were found on the adjoining surface of the ground, and in the pit itself. Though much of it had been thrown back unmanufactured, several flakes were nevertheless discovered. At a distance of 7½ ft. below this layer the flint was reached (7 inches in thickness) and worked out to the extent of the pit, on a level with, and never below the floor. Galleries were then excavated in various directions. The floor flint he tells us is much deeper than at a spot one mile to the S.W. (Botany Bay), where in 1870 it was being worked, but twice the thickness and of finer grain and texture.

The galleries averaged 3 ft. in height, though in some places 5 ft., and in width 4–7 ft. A plan of these is given in both accounts. It shows the same system of working as in the galleries excavated by us. In neither of them, however, is the regular radiate figure seen as in the published plan of the Cissbury mines. One of these galleries was 25 ft. in length, and terminated in a cul-de-sac worked in three apses in which were two deerhorn picks for right and left hands. The doorway into this gallery was 4 ft. high and 4½ ft. broad—a good deal higher than the majority of the entrances in Pit 1., only one of which (gallery 5) was as high. As the top had fallen in this was probably originally lower. The Canon concluded the roof of

this gallery had fallen in whilst the men were absent, and had not been re-opened, their tools remaining where they left them. This may have been the case. The gallery would however be left open whilst the miners were at work to enable them to obtain access, and a fall of the roof would have to be very extensive to fill a gallery 3–5 ft. in height. Moreover, there would be a large space above the fallen chalk through which the miners could still obtain access to the end of the gallery. In five galleries in Pit 1 and two in Pit 2, deer-horn picks were found lying on the rubble floor beside the layer of flint which was being worked. They were apparently left there as useless, and the galleries leading to the culs-de-sac were filled in with chalk more or less to the roof. In this gallery of Canon Greenwell's pit was found a bird's skull, lately identified as Phalarope, lying near the picks. Four feet from the entrance of the same gallery was found a ground basalt axe of a type common in Yorkshire, one edge of which had been accidentally chipped. This axe had been used to extract the chalk both before and after it was accidentally chipped, as marks were found on the walls before the implement itself was uncovered. Gallery 2 was long and narrow, 28 ft. in length, but sufficiently open for the explorers to squeeze through and reach the bottom of an adjoining shaft, which owing to the infilling blocks becoming jammed, was open for a little distance. Near the end of this passage was a perfect deer horn pick, a hammer stone, and on a ledge of chalk a lamp—one of four found, none of which bore any signs of grease or soot.

Lord Rosehill tells us "the bottom of the shaft was only reached on April 5th, 1870," a few days before they left Norfolk, and very little time was available to examine the galleries and their contents. He further tells us the work was carried on for three successive years before the bottom was reached, the material being carried up a ladder in baskets on the heads of labourers. This excavation, too, judging from the loose material filling up the pits excavated by us, must have been distinctly dangerous as the whole shaft was not cleared out but a third of the contents left standing, and consequently they were unable to obtain access to the galleries on that side. The plan shows that only one wall of the shaft was exposed, and the base measurement of the shaft can only be approximate. Of the 79 deer-horn picks, 11 were of slain animals, most of them coming from the galleries. The handles averaged 18 inches, the brow-tine being retained for use as a pick. These picks had been made up by partly cutting through the superfluous tines with a flint flake and afterwards severing them by burning, marks of which were seen on several. In one place 8 of these picks were found together, some of which bore the print of the quarrymen's fingers. The marks in the chalk of the galleries were as fresh as if they had just been made. The picks had been used as hammers, marks of which were also visible on the walls. Evidence of their use for splitting up the blocks of flint was obtained. "In one instance a piece of flint was firmly fixed in the back of the horn, where the appearance showed that it had been used in splintering the flint."

In discussing the question of access to the mine the Canon remarks "there were no steps cut in the side of the pit or any provision of that kind for obtaining access to the galleries, so that the workmen must either have been drawn up by ropes probably of hide, or have ascended by means of a ladder, which if such was the case was most likely made by cutting notches in a tree stem." (The method at Spiennes is described under that section). In addition to the picks were some 13 cut ends of horns and tines, one bunch of which had been used. In the shaft were also found a bone pin or awl, rubbed to a point, and a rounded piece of bone 4½ inches long (of roedeer bone) carefully rubbed smooth. The Canon suggested this might have been used for taking off the lesser flakes in making arrow points. As anything approaching an arrow-head is conspicuous by its absence from the whole "Cisbury" culture, this can hardly have been the case. In addition there were some pieces of carved chalk, one of them perforated and others representing parts of a human model. The Canon remarked that a factory existed at this spot, and that chipped pieces were thicker as the pits were approached, and that the field south of the pits was covered with chipped flints. Many of the pieces described were from the adjoining fields, and an examination of those in the British Museum confirms this. The typical implement found was an adze flat on one side and more or less convex on the other face. One of these is figured (fig. 5) in his account. Two came from the pit on the west side, and Lord Rosehill remarks on their very ancient type, almost resembling the flints of the drift. This implement is clearly similar to some found in our excavations. The other implements mentioned are: a long celt, like a neolithic pick, blunt at the ends, 4–5 inches long, few of which were perfect, used for agriculture or mining or for the making of wooden articles; drills (fig. 3, Ethnol. Journ.) and knives (fig. 1). Round or oval scrapers are described as common (fig. 7), and a rounded core (fig. 4) which resembles a tortoise core found in Pit 2. Fourteen quartzite pebbles and 7 large cores used as hammers were found in all, and a "catshead" nodule (presumably the hammer previously mentioned) was found in gallery 2. No sign of the polishing or grinding of flint came to light, and comment is made on the absence of gold, amber and jet used for barter in the Bronze age.

The Canon came to the conclusion the pits were of the Neolithic age, though a very extended period was required for their construction. He remarks there "can be no doubt that the whole space occupied by the pits is a complete network of galleries," and that if the chalk rubble were taken out of them, it would be possible to travel underground throughout the space in question. He also concludes that implements were manufactured at the Graves, and gives the opinion that the implements from the surface are of the same date, especially those found in the fields to the south.

As will be shown under "patination" the pieces lying on the surface south of the Graves are chalcedonic or entirely black, many of them moreover being scratched, a feature only shown by a single piece from the Grime's Graves area. It is exceedingly rare, too, to

find any white pieces on this surface. It is interesting to note he thought very few people were employed owing to the absence of pasturage, as the same conclusion is reached by an examination of the galleries of our pits.

FLINT MINING IN OTHER AREAS.

The whole subject of prehistoric mining is one of very great interest. The importance of an area from which the best quality of flint could be obtained was in earlier times very great. It is surprising that no protection bank or line of earthworks is to be traced to defend this valuable possession, which in prehistoric times would be coveted by neighbouring tribes. Grime's Graves is the most extensive mine in England—far larger than the better known site of Cissbury, and second only to the Belgian mine of Spiennes, which apparently supplied flint to the whole of Western Europe.

In order to throw as much light as possible on the date of Grime's Graves, I have given a brief account of these two parallel sites, and have added some notes on a few mines of small proportions, pointing out incidentally various comparisons. In doing this I have approached the subject from the mining point of view and have made no comparison between the types of implements found on each spot. For this the reader is referred to Mr. Reginald Smith's account of the implements in the present volume, and the paper by the same author in Archæologia, Vol. LXIII. in which references to various mines will be found. No exhaustive account of the Spiennes implements in the light of modern discoveries has yet been written, and it is to be hoped the deficiency will soon be filled.

SPIENNES.

The mines and workshops of Spiennes, the well-known site in Belgium, afford an interesting parallel with Grime's Graves, and through the kindness of M. Rutot, a corresponding member of the "Prehistoric Society of East Anglia," I am able to give some facts which throw a light on some of the obscure problems at Grime's Graves. Attention was first called to these workings by M. Toilliez as far back as 1840, when the old galleries were laid bare by repeated landslips, and quarrying took place in that neighbourhood in order to obtain flint for the making of earthenware. The extensive collection made by M. Toilliez, obtained partly from the old mines and partly from the surface, was purchased by Sir John Evans in 1865. The area covered by the workshops of Spiennes extends for 25 acres on either bank of the river Trouille. In 1867-8 a cutting was made through the Spiennes district for a railway from Mons to Bencke. The shafts of the old mines were then exposed, cut through three quaternary deposits (containing mammoth,

rhinoceros, and drift implements), and an Eocene sand into the Spiennes chalk for the extraction of a particularly good layer of greyish flint.

Some 25 of these shafts were exposed at that time, and MM. Cornet and Briart, assisted by M. Houzean de Lehaie, embodied their researches on the site in an important paper "Upon the Polished Stone Age and the Prehistoric flint mines in the Province of Hainault."

The old workings afford at Spiennes a satisfactory explanation of how the miners discovered the layer of flint best suited to the making of implements, a problem which entirely eluded us at Grime's Graves.

The cretaceous beds at Hainault occur as outcrops round the chalk gulf of Mons, covered for the most part by considerable quaternary and tertiary deposits. The flint, too, is laid bare in numerous natural cuttings caused by watercourses. The first excavations were in the open on the plateau, where the chalk was barely covered, and in the steep bank of the ravine of the river Trouille. From the ravine the miners drove galleries into the hillside, leaving heaps of chalk-blocks, roughly hewn flints and flakes, still to be seen on the river bank. As soon as this easily accessible area was worked out and driving galleries became dangerous, the work of sinking circular pits on the plateau to reach the flint bed was commenced. These pits were 3½ ft. in diameter and 30-40 ft. deep. In places, however, they cut through quaternary beds 13-16 ft. in depth, and the discovery of one of these pits without the explanation given above would have raised the same question as at Grime's Graves. In one of these pits the beds cut through were brown clay, 1m. 50, yellow clay (ergeron), 4m., and pebbly deposit, 1.m. 50. These corresponded with the quaternary deposits in the Mesvin cutting, the pebbly deposit being the same as that in which elsewhere mammoth, rhinoceros, and flint implements were found. Below this was 2m. 50 of tertiary greensand on a bed of shingle and large blocks of chalk flint. Beneath was the white chalk with the flint layer they were seeking, into which they drove the galleries. The infilling of one shaft consisted of blocks of chalk below and a débris above made up of sand, clay, chalk blocks, nodules and flakes of flint, bones of various animals, brown unturned pottery, only slightly baked, made with a paste of granulated flint, instruments of bone and deer horn, and quantities of flint implements, mostly roughly hewn, but, in some cases, carefully chipped.

In the galleries, some of which were cleared, were found deer horn implements, sandstone hammers, and flint picks, the marks of which were clearly visible on the walls. The absence of flakes in the galleries was particularly noticed, and it was concluded from this that the picks were made on the surface.

Another pit had a funnel-shaped opening and the shaft was closed with chalk blocks, below which was a sloping layer of black clay with wood charcoal. In this were found two knives, a scraper, an axe, jaws of deer and fragments of deer horn, the skull of a hare

or rabbit, that of a young wild boar, some partly calcined bones, and a large piece of coarse hand-made pottery, badly baked. The fauna found consisted of recent animals, with some "which the advance of civilization had driven away or exterminated."

The fields on either side of the river Trouille were covered with flint refuse, in places 1 metre (39 inches) deep. This fact has given rise on the right bank to the name Camp à Cayan (the field of stones), or Champ à Cailloux (the flint field). Whether any polished pieces were actually found in the shafts or galleries is not definitely stated—nor is there any mention of polished axe marks on the chalk walls, and we may conclude from this no pieces were found there. A considerable number of polished pieces were found on the surface, but the great majority were chipped only. No deer-horn picks were found at this time.

The only human remains were in the bottom of a pit investigated by M. G. Neyrinck in 1868, of 12 metres (39 ft.) in depth, where a portion of the skeleton of a child 12–14 years of age was found, and the lower jaw of a man. These were left to the Museum of Brussels by M. Neyrinck, together with his fine collection of flints from this district, and are described by M. Rutot. With these human remains were deer-horn picks for one or two hands, flint implements 20–25 centimetres in length made from cores, pointed at one end and roughly shaped by hammering at the other; and hence designed for use in the hand. The deer-horn picks, however, were few in number, and M. Rutot mentions they were of less diversified form than those from the older mines at Obourg. It is difficult to see how a deer-horn pick could assume many forms. "One-handed picks" are presumably those with a short handle. M. Rutot also makes no mention of polish except from the surface, some of the axes and choppers being treated in this way "more or less." The implements from the plateau varied from roughly hewn to finely chipped axes in all stages of manufacture, the latter he states being "destined for polishing."

In 1911 some shallow depressions were excavated by Mr. C. Stevens, attached to the Brussels Museum. One of these proved to be a kind of vault supposed to form the base of a dwelling. In it were found two superimposed hearths with wood charcoal, a fine arrow-head of Spiennes flint of elongated triangular type, a bone piercer, and coarse pottery, and two metres (6½ ft.) below the second hearth was undisturbed clay. The upper part of this hollow contained quantities of finely flaked cores, and diverse implements, fine blades, rough axe shapes, and finely chipped axes. Above the hearth was a male skeleton of the Cro-Magnon type, and that of a child with a deer-horn pick below. These were 1 m. 40 below the surface, the whole being 3 m. 40 in depth. Another vault coupled with this contained a hearth, bones of ox, horse, and goat, and fragments of pottery. M. Rutot assigns this latter site to the same period as the mines and considers the skeletons belonged to the same race as the miners. It is difficult to see how this conclusion is arrived at from the evidence given above, especially as a triangular arrow-head was

found with the remains. The number of implements left on the fields round Spiennes can be estimated from a note at the Congress of 1872, when M. Lehaie exhibited a cartload of rough axes.

MM. Cornet and Briart record other mines in the neighbourhood, notably at Ceply, where the chalk forms a steep escarpment. At the foot of this are hollows called "Saracen's Holes," which when opened in recent times in the search for flint for the making of pottery disclosed ancient galleries with deer-horn implements and chipped flints. The black flint of Ceply was also mined in shallow excavations where it outcrops near Mons, this flint being also polished—the whitish flint which occurs there being discarded. The railway cutting also brought to light seven pits in La Flènu district, no indication of which was seen on the surface, smaller in diameter than those at Spiennes. The galleries were not reached on this spot, but the profusion of chipped pieces on the surface, over an area of 7–8 acres, specimens of which were presented to the British Museum, make it practically certain that mining was here carried on. When gun flints were still much in demand, this area was extensively worked for that purpose, as at Brandon.

Some interesting observations on patina are recorded by these authors. It was found that the implements of the grey-brown Spiennes flint were unchanged when buried deeply or when left in the galleries. The surface pieces, however, which had for generations been turned over by the plough were patinated white and iron moulded, the latter attributed to agricultural implements. The black flint from "Saracen's Holes" and from the chalk of the "Rabot planes" had not patinated white, whilst that from La Flènu, as can be seen in the British Museum, had acquired a reddish colour crossed with lines of dirty grey. The latter had also acquired iron staining when on the surface.

In 1912 two shafts 40 ft. apart were cleared out at Spiennes. One of these was 52½ ft. deep with a surface diameter of 11½ ft., and the other 46 ft. deep with a like diameter of 8 ft. Each however had a chalk shaft of 3¼ ft. only. They were, therefore, bell-mouthed, and one opened out at the bottom like an inverted funnel, presumably to prevent pieces falling on the miners as flint was carried to the surface. In 18 by 27 yards 9 shafts were found varying from 47–52½ ft. in depth. The whole number, however, in the area is estimated in thousands, and it is consequently far more extensive than Grime's Graves. The shafts were found to be the dumping grounds for workshop refuse and the material taken out of other shafts. Ten layers of flint were cut through before the one wanted was found. This proved to be 15–20 inches in thickness. From the base of the shaft, galleries radiated in all directions. The walls of the galleries were perforated so that the whole area apparently rested as at Grime's Graves on buttresses of chalk. These galleries were 5–6 ft. in height and the same in breadth. No lamps were found, but notches were cut in the wall of the shaft to hold wooden beams, which formed a staircase for access to the mine. 1500 flint picks were found discarded in a space of 110 yards. Photographs of the

galleries showing the rough buttresses supporting the roof, flint picks, and a piece of chalk with pick marks, were published in the "Illustrated London News," March 7th, 1914.

Unfortunately, owing to the war, my correspondence with M. Rutot came to an abrupt termination, and I was unable to get the full report of these latter investigations. It will be seen from this account that the mines at Spiennes form interesting parallels with and differences from those of Grime's Graves, apart from the prevailing shape of the implements. In order to emphasise these I have drawn up the following comparisons:—

1. From the skeleton found in 1911 the miners at Spiennes appear to belong to the Cro-Magnon type. The earlier skeleton was in too fragmentary a condition to form any opinion. (In a letter Prof. A. Keith tells me this skull belongs to the same race as the Grimes-Cissbury skulls).
2. The flint used at Spiennes occurred at a greater depth and had above it 10 layers unsuitable for making implements.
3. The miners did not sink a shaft at random but ascertained the existence of a good seam of flint from a spot where it outcropped on the surface and was exposed in the ravine. In the absence of an outcrop of floor-flint at Grime's Graves we should from this parallel assume the miners arrived at the spot with full knowledge of its existence derived from elsewhere.
4. The implement used for mining at Spiennes was mostly a flint pick, but to some extent those of deer-horn also. The deer-horn picks were not used as hammers as at Grime's Graves, but specially made for the purpose by cutting off the horn close to the burr and using the brow tine as a handle.
5. No polished implements were found in the galleries or shafts or used in the former, and in this respect the site differs from Grime's Graves as will be shown later.
6. Implements were not chipped in the shaft or galleries, but on the surface of the adjacent area, and in this respect the two sites are similar. A few flakes were however found in the galleries at Grime's Graves; but it is not unlikely they came in from the top and were thrown into the galleries with the chalk rubble.
7. Bone and deer-horn implements were found at Spiennes in the shafts, and these are recorded from Canon Greenwell's pit.
8. The galleries were 5-6 ft. wide and high, and seem to be somewhat larger at Spiennes.
9. Badly baked pottery was found on both sites.
10. The fauna consisted of recent wild and domesticated animals and included at Spiennes the wild boar. The skull of hare or rabbit is also mentioned at Spiennes, and the differentiation would be of great importance in England.
11. The patina of the flint is the same in both cases under similar circumstances.

12. In both cases the old shafts when partly filled were used as dwelling places.
13. The disused shafts were used as dumping grounds for the material taken out in digging new ones.
14. The most marked difference is in the diameter and shape of the shafts at Spiennes. Two pits were 11½ ft. and 8 ft. respectively at the mouth and 3½ ft. in diameter when the chalk was reached, one of them opening out again below. At Grime's Graves the three shafts were far larger, viz., Pit 1—29 by 32 ft. at the mouth, 10 by 11 ft. at the bottom, with 12 ft. diameter in its vertical part; Pit 2—42 by 43 ft. at the mouth, and 14 by 14½ ft. at the base; Canon Greenwell's pit—28 ft. diameter at the mouth, and 12 ft. at the bottom. At Spiennes, too, a system of steps was found, which the large diameter of the pits at Grime's Graves would hardly permit. Bearing in mind the small size of a modern shaft this difference in diameter seems to indicate a great difference in the age of the two industries.

OBOURG.

Of the little-known mines, that of Obourg, in Belgium, presents some points of interest in comparison with Grime's Graves. It is referred by M. Rutot to the middle Neolithic period, contemporary with Campigny and older than that of Spiennes. Campigny, as Mr. Reginald Smith has shown ("Archæologia," Vol. LXIII.), has many points of resemblance to the Aurignac Cave period.

The mining, as we have seen, commenced at Spiennes as an open trench on the plateau where the flint cropped out on the surface and in the ravine. There can be little doubt that the mining at Grime's Graves commenced somewhere in the neighbourhood in the same way. The Obourg flint, a particularly good seam for the manufacture of implements, lay some 9¾ 13 ft. below the surface, and access was obtained to it by parallel trenches in the "side of a declivity." It was not, however, entirely an open mine, but marks an intermediate stage—as in one case a gallery was being constructed to link up two hollows when the miner met his death from a fall of chalk. The chalk at the spot was full of fissures, and, moreover, weakened by the intrusion of well-like pockets of Landenian sand. This skeleton was found by M. Ede Munke still to have a deer-horn pick in his hand, and in the use of deer horn picks for mining this site resembles that of Grime's Graves. The picks used at Obourg were for one or two hands, and deer-horn was also used as tools, generally pierced with a hole for hafting. Some appear also to have been used for agriculture—as a kind of hoe, and others formed elongated axe-hammers, one extremity being bevelled.

No flint implements were used in working the mine, but immense numbers of flakes, chips and cores came from the infilling,

together with scrapers of medium size and fine workmanship, which, as mentioned above, M. Rutot compares with those from the Campigny beds of Elonges. A workshop found by M. Dubreux contained the same type of implements, all made of the black Obourg flint, viz., chisels, picks re-worked (but not miners' tools as they were never found in the trenches), scrapers of various types, knives, borers, sling-stones, hammers, etc., some of which are figured in the account.

The fauna at Obourg is a wild one, viz., large ox, roe, red deer, horse, and wild boar, and in a measure corresponds with Grime's Graves.

STREPY.

The parallel site of Strepy, where a similar trench was excavated, yielded two skeletons—one of a miner face downwards, the other a child of four years of age—with two one-handed picks of deer-horn and several two-handed ones, and several implements of deer-horn but none of flint. With the skeletons were the remains of a wild boar with enormous tusks. No workshop was found at Strepy, and the blocks of flint seem to have been removed to Obourg to be cut. The shape of the skull, M. Rutot remarks, is that of the Furfooz race, and belongs to the Magdalenian, with much-worn teeth and pronounced dental caries. In a letter, Prof. A. Keith tells me these skulls belong to the round-headed Bronze Age race, and this would seem to place Obourg after, instead of before, Spiennes.

CHAMPIGNOLLES.

A little-known flint-mine was discovered in 1890 by MM. Bessin and Fouju in a chalk-pit at Champignolles, Oise, some of the shafts having been cut into and exposed during the removal of chalk for the purpose of marling the land. A section of these pits and plan of their galleries is given in "L'Anthropolgie," Vol. II., 1891. Eleven pits were found, and nine of them cleared. They were found on the slope of a ravine, and two of them occurred at open workings at a spot where a good layer of flints cropped out upon the surface, two layers being previously discarded. The other pits higher up the slope were sunk to the depth of one of these discarded layers, which was worked by means of galleries. Here also two unsuitable layers were passed through. These pits were bottle-shaped, having a diameter of 21 ins. at the mouth, 39 ins. in the centre of the shaft, and widening to 56 ins. at the bottom, the depth being 13½ ft., while in the open workings it was 11½ ft. The lower part of the galleried pits opened out to form a dome, 4 ft. 4 in. to 6½ ft. in width, and about 2½ ft. in height, and from this centre ran galleries sometimes communicating with a neighbouring pit, and sometimes forming a cul-de-sac. These galleries averaged 2½ ft. in width and the same in height, this being limited by the upper flint layer. The galleries were filled in with unweathered chalk-blocks.

The walls and detached chalk-blocks showed parallel marks caused by deer-horn picks, which MM. Bessin and Fouju thought to have been used as levers. The shafts were filled in with material thrown out from neighbouring pits, the re-fill showing the layers in reversed order, viz., surface soil at the bottom, with marl, chalk-blocks, and dusty chalk above. These layers sloped down from the surface edge, and contained some waste flint and chipped débris. From the direction of the tips could be noted the sequence in which the pits were being dug. Charcoal, not identified, was found among the blocks. In the shafts were found several antlers which bore cut-marks. In the galleries four picks came to light, with two antlers and a crown of four tines, with cut-marks. Very few implements came from this mine. At the bottoms of the shafts were found a rough axe chipped on both faces with a sharp cutting edge at the end; also a flint pick and two blocked-out axes; and from the galleries came a triangular flint pick, 14 cm. in length, three rough axes, and a roughly chipped piece with two encoches.

In the case of these mines, a knowledge of a good layer of flint was evidently derived from an out-crop on the hill-side, and the layer was followed by sinking pits, of which the traces were completely obliterated higher up the slope as at Spiennes. The adjoining fields formed an area of about 500 yards covered with the débris of a workshop, where the flint was chipped into the form of implements, many rough axes having been obtained from this area.

OTHER FRENCH MINES.

Four other sites of flint mines in France are mentioned by M. Cartailhac, "La France Préhistorique" (1889), viz., Petit Morin, Marne; à Nointel, Oise; Bas Meudon, Seine near Paris; and Mur-de-Barrez, in Aveyron. The two latter are shown in section. The pits at Mur-de-Barrez were discovered accidentally by MM. Boule and Cartailhac in a chalk quarry—no indication being found on the surface. They were sunk through Miocene beds on the side of the valley of the Trinzère, where seams of flint crop out on the surface. So that here, at Champignolles and Spiennes, it is easy to see why the miners passed through several layers of flint and knew of a good seam below. The shafts at Mur-de-Barrez were funnel-shaped, and several inferior flint layers were discarded before the selected seam was reached. This consisted of lenticular nodules of great thickness—far greater than at any spot of which I have a record, as it is stated that buttresses of flint were left to support the roof of the galleries which were cut in irregular directions in following the flint. In the diagram the galleries are seen to run only in the flint layer, and this must consequently have been quite 2½ ft. in thickness. The shafts were filled after the area was exhausted, and M. Cartailhac suggests this was done carefully to prevent accidents. M. Boule found several deer-horn picks caught between falling blocks of chalk and broken, showing how dangerous the operation of mining must have been at this spot. Deer-horn picks were used and the

marks of these were seen on the walls. It is also recorded that some of the points were found sticking in the chalk, a feature not found elsewhere. From this one gathers the brow-tine was used as at Grime's Graves. However a diagram of a deer-horn implement found at this spot shows a very different form. It is made from the shaft of an antler cut off square at one end—and the tine removed. The other end is cut diagonally, making a useful sharp edge, which would make a smooth concave mark on the chalk. The implement, however, is perforated at right angles to the broad edge of the adze, and must have been a very clumsy tool. It is interesting to find that fires were found here in the galleries, through the agency of which the flint blocks were split up. It is recorded too that cords must have been used to withdraw the flint from the mine, as grooves were found in the chalk in the same way as at Grime's Graves. The flint was not worked on the spot, but carried elsewhere, as no workshop or débris was found in the neighbourhood, and no flint implements are recorded.

CISSBURY.

An account of Grime's Graves would be incomplete without a comparison with the Cissbury mines, which in some important respects show closer parallels than do any other site. Canon Greenwell's work at Grime's Graves afforded the clue to the true nature of the pits at Cissbury, which, up to that date, were looked upon as the dwelling places of the men who made the implements so profusely scattered over that area.

It seems evident, from the fact of some of the pits lying outside the rampart, that the name and the camp are later than the mines, and that the fortifications were not erected to defend the miners. From this it would seem that the mining at both Grime's Graves and Cissbury was carried on in a peaceful period.

In the size of the shafts we have a striking point of resemblance, some of those at Cissbury measuring 70 ft. at the mouth. One of the earliest pits excavated was 22 ft. and one of the latest 66 ft. The diameter of the chalk shaft varied, however, considerably, Mr. Tindall's pit being 5-6 ft. in diameter at the base, whilst another was only 4½ ft. It is doubtful if any of the shafts at Grime's Graves are as small as this. In the shape of the shaft there is, too, more variety at Cissbury. One is described as D shaped, another oval, and another square. The three pits excavated at Grime's Graves though not quite symmetrical are very nearly circular. Pit 2 had a more rugged appearance, but the chalk was in a friable condition and a good deal of the lower part of the shaft wall had fallen. Pit 1 was cleanly cut, possibly because the chalk was firm, and the more symmetrical shape suggests greater skill in the art of mining. The depth of the cups before the excavation commenced varies in both cases, from a few inches to as much as 12 ft. This, to a large extent, depends on the amount of material thrown in to fill up the empty shaft, as on both sites these were used to get rid of the material thrown out when a new one was

being dug. To some extent, too, the infilling of the shafts is due to rain-wash, and at Grime's Graves, as has been shown, blown sand contributed an appreciable amount. At Cissbury, where the surface is covered with turf, there does not appear to be any chalk rubble surrounding the pits, as at Grime's Graves, but as the area was used afterwards as a camp, it is possible the edges were smoothed over and the encircling mound obliterated.

The amount of surface deposit through which the shafts were sunk seems also to vary considerably at Cissbury. In one case the chalk lay close beneath the surface, and this was probably the site of the first pit. In another it was 5 ft., and in a third 17 ft. below the surface, the surface deposit being made up of Eocene beds. The depth of the pits at Cissbury varies considerably, two being 30 ft. deep, whilst two others were 30 ft. and 39 ft. respectively. This difference of depth is accounted for by the position of the shafts on the hill-side, and by the tilting of the flint seam which rose at an angle of 5° to the north. At Grime's Graves the flint seam was nearly horizontal, the difference in the depth of the pits being dependent on the amount of the deposits on the chalk and the slope of the hill. The floor flint appears to have been worked at a level with the floor as at Grime's Graves, and at 10 ft. above, an inferior layer corresponding to the "wallstone" was cut through at Cissbury.

The infilling of the shafts in each case is made up of material from other pits, but in some at Cissbury it is more largely rain-wash. In the case of Cissbury it was composed of large blocks, fine rubble, and red clay. Carved chalk and tools of deer horn came from the shaft, and in Mr. Tindall's pit quantities of red deer antlers of slain animals, and single tines in the lowest 24 ft. In comparison with the quantity from Grime's Graves, few deer-horn picks were found in any of the pits or galleries. There is no record, however, of any marks other than those of deer horn picks in the galleries. Pottery was also found at Cissbury. (For comparisons between this and the Grime's Graves pottery see Mr. Reginald Smith's report). The published account of the galleries at Cissbury shows they were driven in a more regular manner from the shaft, the diagram resembling the spokes of a wheel. Some of the pits, however, had no galleries. A pit excavated by Mr. Willett was D-shaped, and in the plan of the galleries continuous walls and isolated buttresses are seen. One of these buttresses is marked "stalagmite," but there is no reference in the text to any material except chalk, nor are any sheep or air holes described, such as were found at Grime's Graves.

No polished axe marks are recorded from the galleries nor ground pieces either from the galleries or shaft with the exception of three, one of which was only 1 ft. from the surface, but one of the antler tools bore marks of grinding. In comparison with this, at Grime's Graves a number of polished axe marks were recorded from the galleries, and a polished axe came from the surface, found by the Rev. Powley.

The fauna whilst showing a general correspondence varies in particulars. At Grime's Graves remains of domesticated animals and certain species of wild ones of the present fauna were found in each shaft in the upper part; no bones except red deer and the skull of a species of duck came from the galleries. In some of the pits at Cissbury a purely wild fauna was recorded, and in others a domesticated one, remains of some of the latter being found in the galleries. The total absence of bones of domesticated animals at Grime's Graves below the boulder clay and sand is a marked difference, as is also the absence of these from the galleries. Whether this distinction is absolute can only be determined by further investigation. Similarities in the human remains are given in Prof. A. Keith's report.

The mollusca at Cissbury were not extensively investigated, the only shells recorded being *Helix nemoralis*, *H. arbustorum*, *H. lapicida*, *H. rotundata*, *Vitrea cellaria* and *Pomatias elegans*, and *Ostrea edula*. (For comparison with those from Grime's Graves see special report by Messrs. B. B. Woodward and A. S. Kennard.) Remains of furze, willow, and beech came from Cissbury and may be compared with those identified by Mr. Clement Reid in the special report. No means of access was detected at Cissbury, but in Mr. Willett's pit a ledge of chalk 8 ft. long was found 10 ft. from the bottom, on the east side, and it seems possible this pit, which was D-shaped, had a series of chalk ledges cut in the side which formed steps by which access was obtained to the galleries. In Mr. Tindall's pit five blade bones of *Bos longifrons* and pig were found with the spines broken off, and it was thought these had been used as shovels. It is clear that some sort of shovel was used at Grime's Graves, as the fine chalk was piled up in the galleries; but no trace of anything of the sort, either bone or wood, was discovered. Water appears to have been brought to the Cissbury mine from a spring at Broadwater, 1½ miles away, along an ancient road which can still be traced. Part of a large vessel suitable for this purpose was found. At Grime's Graves the water supply was a problem both for the ancient miners and the modern investigators, and one can only surmise it was carried a considerable distance. Chalk lamps were found at both sites, but of different patterns; that from Mr. Tindall's pit still had the edges blackened. In both cases there were signs of abrasion and wear in the walls of the pits. In pit 2 at Grime's Graves it was in the upper part of the shaft where the chalk fall had been preserved by sand and boulder clay which had covered it. At Cissbury it was seen in the lower part of a pit, and no doubt remained visible owing to the protection afforded it by an infilling of blocks thrown in before the chalk face had crumbled. A very interesting similarity between the two sites is seen in certain marks found on the chalk face. Those from Grime's Graves are described subsequently. Those from Cissbury were described by Mr. Park Harrison, and diagrams are given in Journal of the Anthrop. Inst., vi. One set bears a resemblance to the "Sundial" in pit 2. It consists of six nearly parallel vertical

lines and one diagonal one. Another set is made up of curved lines crossing each other. The other marks noticed under the arch of a gallery in Mr. Willett's pit resemble the letter L and the number 1, and in another spot were the numerals 16 in brackets. No parallel to these was found at Grime's Graves. A third set consisted of two vertical lines, one of which is crossed by a diagonal one, both being crossed by a horizontal one. All these, from Mr. Willett's pit, were only noticed after it had been open for a year. Other sets figured by Mr. Park Harrison consist of a vertical line with a small cross at the side; a vertical line with two short diagonal ones crossing it; and a series which is best described as resembling curved round-headed pins, some of them crossing. The other marks were four characters of early type on a block of chalk and find no parallel at Grime's Graves. The patination of the pieces at Cissbury is referred to in a later section.

Certain parallels are found in some of the ungalleried pits and various workshop floors which are assigned to the Cissbury culture. The parallels with the latter are confined to the shape and patina of the pieces, and the same may be said of limited areas on the surface in which a certain facies of implement is found, but where no work has been carried on to ascertain whether a "floor" lies below the surface. Of the latter, Ringland, Easton, and Markshall, described by Mr. W. G. Clarke, and Cranwich, by Mr. H. H. Halls, are examples. Of the "floors" of this date are Icklingham and London Bottom, described by Dr. W. Allan Sturge, M.V.O., and Floor 2 at Peppard.

MASSINGHAM.

Of the ungalleried pits are Massingham Heath, excavated by the late Dr. C. B. Plowright, a pit at Chichester by Captain Wade, several at Maumbury Rings by Mr. St. John Gray, Ringland, and at Peppard site. The pits at Massingham Heath were all of large diameter. One was 5-6 ft. in depth, another with a diameter of 40 ft. by 30 ft. was 8 ft. in depth, another at Grimston Road was 15 ft. deep with a diameter of 80 ft. by 60 ft. A second one at the latter spot was circular and 90 ft. in diameter, larger than any at either Grime's Graves or Cissbury. These were all cup-shaped. The flakes and implements formed a layer 1 ft. thick beneath the turf, and were found in pockets at 3-4 ft. from the surface. The bottom of the pit excavated contained large blocks and deer-horn picks. The implements, which consisted mostly of roughly hewn celts and flakes 5-10 inches in length, some of which were trimmed, were evidently chipped on the surface as at Grime's Graves, and the waste flint and useless picks thrown back into the pit.

CHICHESTER.

Very similar, too, were the pits excavated by Captain Wade at Chichester. One of these was 12 ft. in diameter and 15 ft. deep, filled with broken chalk. Some deer-horn picks were found, one of

which had been used as a hammer. The fauna consisted of pig and sheep. The chipped pieces were found in the pit and not on the surface, and included three rough implements of Cissbury type. Marks of the deer horns were noticed on the chalk. The upper pieces were patinated a dull white; those lower down were blue.

MAUMBURY.

The pits at Maumbury Rings, of which seven were found, lay beneath the Roman amphitheatre. One of these was 10¾ by 6½ ft. at the mouth, and 20½ ft. deep. At the bottom it measured 2·75 ft. by 2·2 ft. It was D-shaped, like one of the Cissbury pits, and the straight edge had ledges apparently to enable the miners to climb up and down. A number of used deer-horn picks were found at the bottom, and remains of ox, young pig, sheep, and dog—a fauna in agreement with that of Grime's Graves. The pottery, however, found at 18 ft. below the surface, had an ornament of three parallel cordons or raised bands, and was slake-baked. Some white flakes were found in pits 8 ft. below the surface, on which they must have lain to become patinated. The pits were dated from the pottery as Neolithic, and are probably later than Grime's Graves, though the fauna and the use of deer-horn picks are parallels.

One of the factors which led to the present excavations was a paper read by Mr. Reginald Smith, B.A., F.S.A., to the Society of Antiquaries in 1912, "On the date of Grime's Graves and Cissbury Flint mines," in which the Neolithic date assigned to these sites was severely criticised. The implements from both these sites, of which a number were illustrated, were shown to bear far greater affinities to Drift and Cave forms, especially from Aurignac sites, than to any established Neolithic one. At Grime's Graves the 13 ft. of sand was commented on, and doubt was expressed whether the miners ever cut through such a thickness. It was suggested this sand might be loëss which had obliterated the entire industry. The anomaly of a single polished basalt axe of Yorkshire type found associated with an otherwise symmetrical culture was discussed, and the various aspects of the whole subject fully entered into. The implements from Grime's Graves from which conclusions were drawn were presented to the British Museum by Canon Greenwell, who mentioned that many of them came from the field on the south of the plantation. The present excavations show that those with chalcedonic patination did not come from the shaft or from the area of the Graves.

THE PROBLEMS AT GRIME'S GRAVES.

From the foregoing account it will be seen that certain facts were clearly established by the careful work done by Canon Greenwell and by other investigators on parallel sites. Many problems remained, however, unsolved. The marked affinities of the implements to those of Palæolithic date from the Drift and Caves was recognised by General Pitt-Rivers, Sir John Evans, and Mr. Allen Brown, and discoveries in the French caves, where a dateable sequence is now established, brought the matter again into prominence. The chief problems to which attention was particularly directed are here set forth.

The principal aim was to throw light on the date of the industry, and around this many points arose. Wide difference of opinion has been expressed as to the date of flint mines, and they have been assigned by different authorities to the following periods: Bronze, Early or Late Neolithic, post Madelaine, and Aurignac. This involves the question of whether mining took place in the Palæolithic age or not.

Connected intimately with the date is the problem of the fauna, whether domesticated or wild only, or combined, or including extinct or migrated animals, and in the case of the dog whether the breed corresponded with other sites.

From this arose the question whether the miners were a migratory tribe paying occasional visits to renew their stock of flint and living by the chase, or specialised settlers who tended their herds and cultivated the fields. Particular attention was directed to any human remains in order to throw light on the race to which the miners belonged, their method of disposal of the dead, and any indication of religious observances connected with it.

Also whether the implements could be assigned to any known period, whether the art of polishing was practised, and whether the product of the mine was bartered in the raw state, or manufactured in the pits or on the surface.

Another problem upon which information was sought was the climate and state of the country at the time; whether wooded or breck, wet or dry, cold or warm; and connected with this were the questions as to whether agriculture, weaving, the making of pottery, or the art of carving were practised.

Also if the pits chosen for excavation gave evidence of any difference of date from each other or from that excavated in 1870, and whether they were worked at one or several periods.

If the pits were sunk through a deep layer of sand or the latter was blown over the area and stopped the work of the miners.

If any explanation could be gained of the large size of the shafts, and whether the state of the walls showed that the pits were worked by a small number of men over a long period, or a large number over a short one.

Whether access to the mine was gained by steps or ladders, what implements were used to carry on the work, and in what

Left : North border of Plantation, with Pit 1 and hut ; soil, chalky debris without bracken.
Right : South-East border of Plantation ; bracken on undisturbed sand. (Photos by A. L. Armstrong.)

way the finer chalk and sand were conveyed to different parts of the galleries, and to the surface, whether by baskets or shovels of wood or bone.

Canon Greenwell recorded the peculiar method of extracting the flint—in which the chalk was never removed below the seam. As the modern miner adopts a different method, attention was drawn to this point as having a possible bearing on the date.

Not least important were the questions involved in the patination of the implements. It has been contended that the more heavily patinated pieces are of older date than those with a thinner coat of patina. The facts ascertained from the sites mentioned in the earlier part of this account seem to show that pieces left on the surface become more thickly patinated than those of the same date buried at a little depth, and that, when buried quickly they remain unaltered if at a considerable depth. Also, that certain kinds of flint do not patinate at all when left on the surface, and that the patinating process attacks the adjacent parts of the surface of a flint in a different manner, forming eventually (in those parts subject to the change) a uniform white.

It was known that a large quantity of implements and chipped pieces were scattered over the surface of the Graves, and the questions arose whether these were older than the mining; or whether an older surface containing chipped pieces lay buried under material deposited since the mines were abandoned. If the mines were sunk through a surface strewn with chipped pieces, as was apparently done at Cissbury, we might expect to find some of these thrown into the shafts; and from the character of the work and patination of these pieces obtain assistance in dating the industry. Attention was also directed to iron-moulding and scratches on the implements. The problem of where the mining first started and how the miners knew of the existence of the best layer of flint called for attention, especially as the wall flint could be made into good implements. As the work progressed the occurrence of a layer of boulder clay across the pit opened up a wide field for speculation. How far these problems were solved will be seen in the following pages.

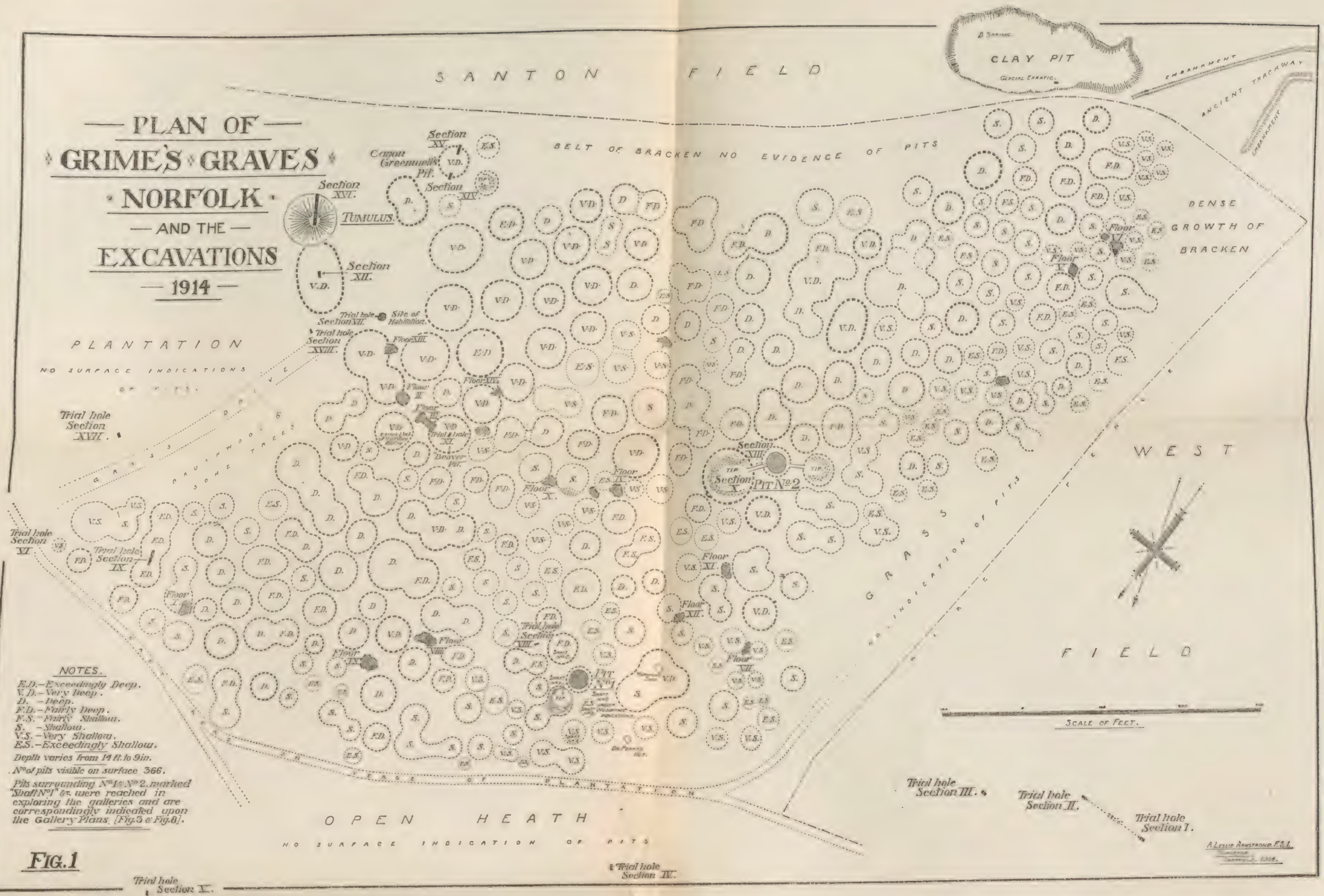
GENERAL DESCRIPTION OF GRIME'S GRAVES.

The prehistoric flint workings are situated in a plantation of roughly triangular shape of 20-21 acres at 120 ft. O.D. (Plate I.) The pits fill up the whole area except a considerable space on the east side. (Fig. 1.) The apex of the triangle, which is on the borders of Weeting, Lynford, and Santon, points to the south. The Lynford base of the triangle consists of heath and arable land; the Santon side, of heath, with arable land protected by fir "belts." To the south are huge areas of bracken, and to the west heathland and one arable field, in which is a pit showing about 10 ft. of boulder clay. The ground on the north-west side of the plantation

slopes to form one side of a valley, beyond which is a large plantation called Snake Wood. The Rev. C. H. Manning calls this slope on the north-west of the pits, White Cross Heath. This valley, the top of which runs a little further to the east, winds down to Brandon, and the main road from Mundford runs along it. Beside the road at the bottom of the valley are seen the banks of a stream, now dry, which pass the ruins of Broomhill Priory, and terminate near the railway station at Brandon. Beyond Brandon is the beginning of the fen district, drained by the Ouse, which was forest up to the time of Edward I., and in which, no doubt, the red deer flourished. On the Santon side of the plantation is a boulder clay pit, in which lie two erratic boulders. One of these was identified by Prof. P. F. Kendall, F.G.S., of Leeds University, as Lincolnshire flint, the larger one being Carstone, from the Lower Greensand of Lincolnshire. Above the boulder clay is a patch of gravel. (*See* Tumulus.) A small spring rises in this pit and occupies an artificial cup in its side. It is doubtful if anything but a patch of dampness would show on the surface if no pit had been dug here. A low bank, 5 ft. wide, runs along this side of the plantation and forms the parish boundary. Close to the apex of the plantation to the S.W. this bank curves to the southward, and runs towards the Ouse a mile distant. Parallel with it for a considerable distance is a higher bank, 15 ft. wide, forming a grass road about 27 ft. across. This latter, which is to the N.W. of the former, is seen to start directly from the end of the plantation, and run in a southerly direction for about 70 yards. It then turns at an obtuse angle to run parallel with the smaller bank in the direction of the Ouse. The space occupied is thus nearly triangular, having its base at the edge of the plantation and its apex at the point where the two banks approach and run parallel. It is possible that this is the commencement of the old road which ran from the plantation to the river, and it is probable that along this road some of the produce of the mine was conveyed. As we shall show, a great deal of the flint was chipped in workshops on the spot: but there is hardly enough débris for all of it to have been used in this way, when we consider the great area over which the mines are spread, and the enormous amount of flint brought up from the mines. The Graves are 6 miles from Thetford, 3 from Brandon, and 2½ from Mundford, in one of the bleakest and most inhospitable areas in the County. The plantation in which the Graves are situated, originally planted, as the Rev. C. H. Manning relates, in 1815, consists of oak, beech, Scotch pine, birch, wych elm, spruce, etc. It is an interesting spot not only to the prehistorian, but also to the botanist, and those who study bird life. The deadly nightshade has forced its way through the chalk rubble, ferns grow luxuriantly in the hollows, and the rockrose is seen in the summer. Crossbills were busy in the pine trees when we arrived, and the Norfolk plover came soon after and nested in the valley. Pheasants built their nests amongst the fallen branches, and a pair of long-eared

* It is referred to by the Rev. C. H. Manning as "the Ride."

PLAN OF GRIME'S GRAVES NORFOLK AND THE EXCAVATIONS 1914



NOTES.

E.D.–Exceedingly Deep.
V.D.–Very Deep.
D. –Deep.
F.D.–Fairly Deep.
F.S.–Fairly Shallow.
S. –Shallow.
V.S.–Very Shallow.
E.S.–Exceedingly Shallow.

Depth varies from 14 ft. to 9 in.

N°of pits visible on surface 366.

Pits surrounding N°1 & N°2, marked "Shaft N°1" &c. were reached in exploring the galleries and are correspondingly indicated upon the Gallery Plans. [Fig.3 & Fig.8].

FIG. 1

A. Leslie Armstrong F.S.I.

owls reared their young in the top of a large pine tree. Very interesting, too, were the nightjars which, towards evening, kept up a continual whirring, broken only by noiseless flights amongst the trees, snapping their beaks as they caught up the insects. Of the wild life, perhaps, the most curious was a pied wagtail, which selected the edge of our second pit on which to make her nest. This she placed in a slight recess on the top of the chalk about a yard from the ladder. In spite of the visitors and the work going on close by she remained there quite undismayed.

Most of the area consists of hills and holes of disintegrated chalk, the former being some of the débris thrown out of the shafts sunk into the chalk for flint, while the latter indicate the entrances to the old shafts, which have been filled in to within a few feet of the surface.

In a general way the whole area bears a striking resemblance to some portions of Lingheath, Brandon, where great quantities of flint have been excavated in somewhat similar fashion during the past century.

Canon Greenwell estimated the number of pits to be about 254. Mr. A. Leslie Armstrong, F.S.I., in making the plan of the whole area, has indicated 346 (Fig. 1); but, in addition, there are others in the fields W. and N., and some in the plantation are entirely obliterated by rubble, as is seen from a shaft reached by the galleries of pit 1, of which no surface indication is left. As the plan shows the pits are not all of the same shape. It is possible to classify them into three groups:

(1). Circular pits distinctly separated from their neighbours by a mound. These are generally of large diameter. To this group belong the second shaft excavated and Canon Greenwell's pit. The first shaft excavated by us was oval, but this outline was due to the amount of material thrown in from one side, and it comes under this class.

(2). A series of pits grouped together in one large irregular hollow with a high mound surrounding the whole. At the bottom of the hollow the outline of the shafts can generally be faintly traced. One such pit of trefoil shape lay immediately west of the first shaft excavated by us, and included three shafts. It was surrounded by a high mound of variable height which spread over some of the nearest shafts and partly obliterated them. Another large excavation of the same kind lay in the S.W. part of the Graves.

(3). Pits sunk close together in a long wavy line. These are mostly seen in the N.E. part of the area. Between the lines chalk and sand were piled up to form broad high mounds. To test the theory that these indicated galleries that had fallen in, Section 9 was undertaken.

These distinctions seem to suggest different methods unless we suppose that the interval between two isolated shafts was originally cleared and afterwards filled in. The lie of the material tipped into Pit 1 rather suggested this, but it seems unlikely in that case that so many of the isolated shafts should have

a completely circular mound. It is possible the isolated shafts are a little earlier, dug before the miners adopted the method of removing the sand and so avoiding the danger of its falling into the shaft. In that case Pit 2 and Canon Greenwell's would be amongst the earlier ones. The richness of the vein of flint may be the true explanation. It would be impossible to keep a thin wall of sand between the pits in Section 9. In this case the miners seem to have removed the boulder clay as well, though, with a slight batter this would hold without danger. The character of the chalk through which the galleries were cut does not seem to afford an explanation, as the neighbouring shafts were further away from Pit 2 where the chalk was in an unsafe condition and liable to fall than from Pit 1 where it was firm and safe.

The pits adjoining the field on the W. and N.W. were filled nearly to the surface, and far shallower than those in the centre. This was clearly due to blown sand, brought from the arable field by the prevailing west wind. (The keepers tell me this is almost incessant.) During the three months spent at the Graves we hardly had a still day. For the greater part of the time the wind blew strongly from the West, bringing with it an appreciable amount of sand, which would be far greater when the field was recently ploughed. That the whole of this part of the Graves is not entirely obliterated by blown sand, can only be due to the fact that the field has only been under cultivation in comparatively recent times.

The diameter of the pits varies considerably. (Plate II.) Two pits on the N. side measured 23 by 25 ft. and 19 by 24 ft. respectively. Some in the N.E. corner varied from 35 by 39 ft. to 41 by 43 ft. The trefoil shaped hollow measured 86 ft. N. to S., 80 ft. across the combined S. arms, and 30 ft. across the N. arm, and it was 10–12 ft. deep. The largest pit of all was that next to the tumulus, measuring 88 by 64 ft. It is not unlikely that this hollow contains two shafts close together. One of the biggest isolated pits is near the centre of the Graves, next to Pit 2, and may be the one referred to by the Rev. Francis Blomefield.

The present depths of the pits vary considerably. Seven picked out as representative were accurately measured by Mr. Reginald Smith, F.S.A., and found to be 6 ft., 6½ ft., 9 ft., 8½ ft., 10 ft., 3 ft., and 1 ft. respectively. This gives an average depth of 6¼ ft.

METHODS EMPLOYED.

In each pit the same method was employed. The cardinal points were taken and stakes driven in to mark them. The untouched cup was measured and a standard level set up. The latter represented a horizontal line taken from the highest point of the surrounding mound and marked by T pieces driven into the ground at the East and West points. A datum point representing the surface of the cup was marked by a peg driven in the side. Posts were subsequently driven in every 6 ft. as the work progressed. The entire circle was divided up into four sections, viz: N.E.,

General view of the "Graves" showing the size of pits.
(Photos by H. Dixon Hewitt.)

Pit 1—(Top) The shaft and its surroundings. (Photo by A. L. Armstrong.)
(Middle) Some of the material from the shaft. (Photo by H. Dixon Hewitt.)
(Bottom) View from above. (Photo by A. Gilligan.)

N.W., S.E., S.W. The letter D added after the number of feet thus denotes the actual depth below the surface as it existed when the work was commenced; and the letter S the depth from the top of the mound. It seemed a better method to mark the implements from the datum point rather than from the standard level; for example, in Pit 2 in the event of an implement being found at 2 ft. below the actual surface cut into, by adopting the standard measurement it would be marked 9 ft. S.

The patination of the flints bore a constant relation to the depth of the pieces from the surface, and it was thought that in the event of the implements being scattered in museums without an explanation erroneous conclusions might be drawn. The top soil for 1 ft. was taken off over the area of the cup to prevent admixture from recent vegetable remains. One of the objects of the work being to find out from which direction the various materials were thrown into the pit, it was necessary to get a good section from E. to W. Consequently, one half only of the infilling was removed at first, as far as it could be thrown out in stages, and the other half after the section had been drawn. In this way, a flat floor was reached in Pit 1 at a depth of $16\frac{1}{2}$ ft. below the top of the mound. The mouth of the pit was then spanned with poles to support a platform, on which was erected a tripod and windlass, and the material raised by means of a rope and bucket and wheeled into an adjoining pit. (Plate III., top.)

In the rest of the pit the same system was adopted, and thus a complete section of one half of the infilling was obtained. When the galleries were reached and access was obtained to them, they were carefully examined by us by means of acetylene lamps before anyone else was allowed to go in. Any objects found were recorded at the time, and the appearance of the roofs and walls and condition of the galleries noted. Photographs were taken of several of the galleries, with picks left on the open floor or rubble by the miners. All objects found were recorded in a notebook at the time with the level and layer in which they were found, and the principal flints were marked in pencil. In Pit 1 all the chipped pieces were saved, the flakes and rough pieces being packed in large wooden cases, of which 10 were filled—in addition to the best ones marked separately. A quantity of the waste flint found in each layer was also put aside and labelled in separate heaps in an adjoining pit for later examination. One of the Brandon knappers eventually identified this waste flint. For the smaller objects, shells, small bones, charcoal, etc., chip boxes were used. Samples of the different layers were taken and preserved in cigar boxes, which proved far superior to those of cardboard, which were liable with the damp to fall to pieces. The horns and bones were dried and afterwards sized, and the pottery preserved with Keilbach's solution. An overseer's hut was provided for the excavators, and having a window, shelf, and cupboard, answered admirably. A rickcloth was used as a protection from the rain, but it was difficult to keep in position on account of the violence of the wind.

A word of appreciation is due to the foreman, S. H. Lloyd, of Thetford, and his two men, who worked willingly and steadily in spite of the inclement weather which prevailed during the earlier part of the work. They took a great interest in the work and quickly learned to pick out the chipped flints. The foreman's experience enabled him to judge the correct angle at which the sand and boulder clay could be left without danger to those below; and thus saved a great deal of time. With the exception of the top layer the whole of the digging was done by him, and I think, when one remembers the capacity of the pit and the time taken to empty it and that necessarily occupied in picking out the "finds," it was a very creditable performance.

The Excavation of Pit 1.

The pit selected by the Committee was oval and measured 32 ft. N.—S., and 29 ft. E—W. It was surrounded by a mound of irregular height and the bottom of the cup was 4 ft. below its highest point. The measures taken to register the finds have been described.

The work was commenced on March 2nd, and our first aim was to find the chalk lip of the shaft. After the removal of 1 ft. of surface soil one point was clearly established, viz., that chalk rubble thrown out by the miners lay heaped up on the sand, and formed to a large extent the mound which encircled the pit. Consequently the mines were not buried by extensive sand storms as had been suggested. Other facts in support of this conclusion will be mentioned later. In order to obtain a good view of the layers of the pit we decided to work out one half as deeply as possible, leaving a vertical face from east to west.

Having found what appeared to be undisturbed sand at both the east and west edges, we decided to follow this down until the chalk was reached. From Canon Greenwell's account we expected to find about 13 ft. of sand, or possibly rather less. As Lord Rosehill mentions, the pit opened by him on the N. side of the Graves was shallower. After two days' work it became evident the pit was filled in almost entirely from the west. As in that direction lay the enormous trefoil-shaped hollow which seemed to mark the sites of three adjacent shafts, we concluded that most of the material came from that area.

In taking off the upper 2 ft. the great tilt of chalk blocks (No. 3) was opened up, and as this contained "floor" flint which could only have come from an open pit to the west, the original theory that the mining started from the tumulus pit and was being extended from east to west seemed to be corroborated. As the trench was extended to the east we came upon the rubble and blocks of layer 2, which came in from that side, and this led us to suppose that more than one shaft was open at one time, a conclusion in

agreement with that arrived at by Canon Greenwell. We further concluded, and this was subsequently confirmed by the directions of the various "tips" and facts gathered from the galleries, that several shafts were actually worked in one spot at the same time. The level of the ground at the time when the mining took place was indicated by a dark line on the top of the sand at the east and west ends of the pit, upon which lay a quantity of chipped pieces. As the material in the N.W. section of the pit was removed we were considerably puzzled by a number of thin layers of chalk and sand which did not run towards the centre of the pit but sloped in a northerly direction.

The foreman suggested they filled up a gangway which led to another pit, and this seems not improbable. It may, however, have been material thrown in from the side of the larger tip projecting into the pit, and would thus fall in that direction. It would have taken too much time to cut away the N.W. face to clear up the point, and we decided to do this when the pit was filled in, as we had reason to suppose at that time would be the case. The condition of many of the pits at the present time, such as those in which we dug Section 9, in which three pits were connected together almost on a level with the chalk, shows that this method of facilitating the removal of material from one shaft to another was certainly carried out in some cases. The pit, as I have mentioned, was oval when the work commenced, and was partly selected for that reason, as it differed from the majority. After five days' work we began to suspect we were dealing with a circular shaft, the original shape being obscured by the mass of material thrown in from the west, and in order to gain the west lip it would be necessary to cut away a large piece on that side from the top. We had followed the soft red sand on which rested a mass of chipped material until we came to a tough layer which proved to be chalky boulder clay which seemed unmoved. This had a steep batter, and we estimated that if it continued to do so at the same rate between the 15 ft. S. level we had then reached it would give us a shaft 8 ft. in diameter, far smaller than that of Canon Greenwell's.

We had not up to this point found the solid chalk, though the 13 ft. of sand found on the S.E. part of the Graves had been exceeded. By making stages it was still possible to throw out the material, and it was decided to cut a deeper trench from E. to W. as the chalk could not be far below. In doing this we found at 16 ft. S. level the boulder clay extended right across the pit. From this fact it seemed uncertain whether there was a shaft or not. The recognition of the layer we were following at the sides as chalky boulder clay by Mr. W. G. Clarke on March 7th raised a very interesting point. This boulder clay had no chipped pieces in it. It was apparently unmoved and extended across the pit, being continuous with the same deposit which lay under the sand in the sides of the shaft. The facts suggested it had been laid down by ice after the mining had to some extent ceased (that was supposing there was a shaft cut in the chalk below, which up to this point had not been

ascertained). If this were the case it was clear that some mining had taken place afterwards, as chalk rubble was found forming the top of the encircling mound with no boulder clay above it. It was not unlikely the whole mining at this spot had extended over a vast period, the latest being comparatively recent. This might account for the rubble on the top of the mound. About a mile to the west shafts were worked in 1870 as Canon Greenwell records. These at the present time form an irregularly-cupped area not unlike that of the Graves, with this difference that the cups at the latter spot are far larger.

We now decided to cut into the boulder clay in the centre of the pit and see to what depth it extended. This was 12 ft. below the surface of the cup. The question of a shaft was quickly settled. Two feet below the surface of boulder clay at this point we found a mass of floor flint and topstone, and near the west end cut into a layer of chalk rubble in which were found three flakes, sharp and unpatinated, with well-marked bulbs of percussion. By following to the west for a little distance this rubble was found to run upwards behind the boulder clay. This led us to suspect we were already well in the chalk shaft, the wall of which lay behind the apparently undisturbed boulder clay. As it was impossible to throw the material out beyond this level it was decided to remove the rest of the N.W. and N.E. sections, then proceed to the S. side, and afterwards set up the tripod and bucket. The method of cutting away one side only of the infilling enabled us to see the relation of the layers, five of which were at this point exposed, as will be seen from Fig. 2. In clearing the N.E. section we struck the solid chalk wall and found the roots of living trees running down between it and the infilling. These subsequently formed a valuable guide.

In the S. section we laid bare the hearth described under the Black Band, and in layer 5 the human skull under circumstances described elsewhere. On completing this work we were compelled to erect a stage, and cut away about 3 ft. of the W. and N.W. walls from the top in order to expose the chalk on that side and prevent any danger of material falling into the shaft as we descended lower. In doing this we exposed on March 16th the curious hole let into the chalk near the top, and the pyramid of flints to the W. of it. This hole it was surmised was to hold a joist of timber for spanning the shaft to facilitate the raising of flint from the mine. (Plate V., top.) A similar one was found on the S. side. Both of these were left for investigation when the pit was filled in, as the cutting back of the face at these points would have weakened the margin and rendered the lower work more dangerous. Owing to the pit remaining open we were unable to follow up this matter and that of the gangway previously mentioned.

We had thus on March 13th a level floor at a depth of 16 ft. below the top of the mound. At this level the floor was made up of boulder clay in the centre and chalk rubble at the sides. By cutting back the boulder clay and rubble we had reached the margin of the chalk shaft on March 12th at the E. and W. edges, and

Pit 1—(Top) Adult human skull, layer 5. (Photo by Dr. A. E. Peake.)
(Middle) Antler-pick *in situ*, 28 feet. The pick had been used as a hammer and the battering of the burr may be seen. (Photo by A. L. Armstrong.)
(Bottom) Entrance to Gallery 2 showing rubbed lintel and thong-grooves in the chalk above. The entrance was partly blocked when the photo was taken. (Photo by A L. Armstrong.)

Pit 1 (Top) Side of shaft, showing hole in chalk, possibly to carry beam across mouth.
(Middle) Entrance to Gallery 7.
(Bottom) Common entrance to Galleries 8, 10 and 11. From this came the axe found by Mr. A. Holden. (Photos by Dr. A. E. Peake.)

following this upwards we were able to define the top of the chalk shaft. We were thus 6 ft. down in the latter. At this level there was still some batter on the wall, but at 18 ft. it ceased and the shaft became vertical. The batter coincided with the layers of soft chalk, the vertical part being cut through a hard tabular layer. This indicates a considerable amount of skill and knowledge on the part of the miners. On March 17th and 18th the mouth of the pit was spanned with poles and a platform built on them. On this was erected a tripod, with windlass and bucket. (Plate III., top.) This method answered very well: and though slower than staging, was a good deal quicker than that of a ladder and baskets employed by Canon Greenwell. The only danger from such a method is in having a faulty stage or rope. The latter broke on one occasion, happily without danger for those below. In order to work out a complete section we continued to clear one half at a time. In deepening the N.W. part we found at 21½ ft. S. the top of an arch in the chalk face. This ultimately proved to be a cove or recess cut in the chalk, having at the base the layer of wall flint with the chalk cut away below it. These recesses varied in width from 2 ft. 9 in. to 3 ft., and in depth from 1 ft. 6 in. to 1 ft. 8 in. They measured 5½ ft. in height, and the three grouped together were 1½ ft. apart. It was in layer 8, at 22 ft. S. level, we encountered the first perfect deer-horn pick on March 21st. Having reached the level of the wall stone at 23 ft. S., it was estimated (if the two flint seams were the same distance apart as recorded by Canon Greenwell) that the bottom of the pit was about 7 ft. below, and as we were anxious to explore the galleries we continued to deepen the N. section, leaving the S. half at the 23 ft. S. level.

Deer-horn picks became very plentiful at this point. On March 24th we found 11, and on the succeeding days 10, 13, 14, 10, and 11 respectively, until a maximum was reached on March 31st of 21 picks, of which 16 were in good condition. These were, however, all from the galleries.

On March 24th we came on the arched head of gallery 1 (Plate VII. top), and decided to clear this before proceeding to empty the rest of the shaft. At 8 a.m., March 25th, by means of a strong acetylene lamp we obtained the first glimpse into this gallery, and at 12.30 on the same day had reached the bottom of the shaft (30 ft. S.) and were able to enter it. The appearance of the galleries when first entered is described in a separate section. The rest of the N. section was then cleared and the head of gallery 2 exposed. Between the chalk blocks of layer 8 the first fragments of pottery were found near the entrance to gallery 1. After the men had finished work, Mr. Armstrong and I managed to get into gallery 2, through the small creephole which formed part of the ventilating system between the two galleries. It proved by subsequent measurement to be 18 ins. wide and 10 ins. high. On the following day the entrance to gallery 2 was cleared, and it was found to be filled with chalk blocks below and a tenacious

mass of sand, which had spread for some distance inside the entrance. This sand formed layer 9, and, as mentioned under "The Layers," started from the bottom of the little recess of wall stone on the north side. At this point, just below the flint layer, a mass of charcoal was found (fireplace 2). As the sand covering the head of gallery 2 dried and was blown off by the wind some smooth grooves were exposed, to which Mr. Armstrong called my attention. (Plate IV., bottom). They were undoubtedly of old date, as sand was still adhering to the face when they were first noticed. They seem to have been caused by thongs or ropes used in working the mine. We had found no bones below the bottom of layer 5, *i.e.*, 16 ft. S. level, except two small ones which proved to be mole at 22 ft. S., and one of a very young rabbit at 25 ft. which might have been blown in from the surface during the night. Some bats' skulls and bones had also occurred between the blocks, but no large bones. However, at 28 ft. S., 2 ft. above the bottom of the pit on the S. side, a large rib came to light, which proved to be red deer. There was, too, in the lower part below the boulder clay an almost total absence of shells, contrasting with the great number above that layer. At 27 ft. S., near the centre of the pit, another fireplace was found (3); and at 29 ft. S., in the S.W. section, a third (4); whilst on the bottom of the shaft, 30 ft. S., still another (5). All these are described under layer 10. Whilst the rest of the pit was being emptied, Mr. Armstrong and Lieut. W. Hall were steadily working in the galleries, the former trying to penetrate No. 4, and the latter the blocked end of No. 1, both of which were completely filled. They eventually cleared a passage and met in No. 4, and the former continuing beyond was able to look through into gallery 5. On the following day the entrances to Nos. 6 and 7 were exposed; the latter was very low and entirely filled. By clearing the sandy tilt which blocked up the entrance to No. 6, it was possible to enter, and through the still open creephole (shown in the plan) to gain access to No. 7, part of which was open. With the exception of a small portion on the west side, the week ending on March 28th saw the whole of the shaft cleared. It proved to be 12 ft. from east to west, and 11 ft. from north to south. Access was obtained to gallery 8 the same day. At the same time the entrance to No. 9 was exposed, and a fine pick was seen lying on the chalk rubble. The following week was devoted to clearing out some of the galleries. On March 30th Mr. Armstrong got through to the end of gallery 10, where he found a chalk lamp; access was also obtained to the end of gallery 3, which proved to be the bottom of a shaft. Lieut. W. Hall and Mr. Casey had removed a great deal of the chalk from No. 7 gallery, which was packed to the roof; and on March 31st Mr. Armstrong got through the end of this gallery into No. 12. Some marks noticed in the apse of this gallery are subsequently described. In the meantime the men had cleared a large portion of the common entrance to galleries 8, 11, and 10 (Plate V., bottom), and completely emptied Nos. 1 and 2, and a good deal of No. 7. Except for picks nothing came to light from these galleries. In

clearing the end of No. 2 and part of Nos. 4 and 14 the men exposed a creephole beyond which could be seen a fairly open gallery, called No. 13. This terminated in the bottom of a shaft.

The Committee met on April 4th and the work in this pit was discontinued; very little was being found, and to a large extent the galleries had been mapped.

It was originally intended to continue the work in the galleries to see if anything of interest lay beneath the rubble, and in view of the flint axe and polished marks ultimately found there, it was unfortunate that the whole of the staff had to work at Pit 2.

On April 2nd, Lieut. W. Hall called my attention to some smooth axe marks in gallery 11, which he had been clearing with an ice-axe. I at first thought these marks were due to this axe. On closer examination they were, however, found to be concave, whereas the blade of the ice-axe is flat, and we came to the conclusion these were the marks of an implement different from anything yet found. Subsequent experiment with the ice-axe, on a block of chalk, failed to produce a concave mark. On the following day he found in gallery 12, which proved to be the bottom of a shaft, a long bone, subsequently identified as the tibia of a red deer, artificially hollowed. This pit was then thrown open to visitors, many of whom availed themselves of the opportunity of going through the galleries, and our attention was directed to Pit 2.

On April 13th, Mr. E. St. Hilary Lingwood called my attention to a number of smooth axe marks which he had noticed in the galleries of Pit 1 when searching for picks. Most of these were in gallery 7 on the two walls of the apse leading into gallery 6. Part of this was originally open, and when I first entered it there were deer-horn pick marks, but no others as far as I could see. The men had cleared out the whole of this part and rendered the gallery accessible through its original entrance. A fine mark was also seen in gallery 2, and one was uncovered in the apse of gallery 13. Another was found by Mr. E. T. Lingwood on the wall of gallery 6, after he had removed a number of blocks. Wax impressions were taken of these marks and a description of them is given later.

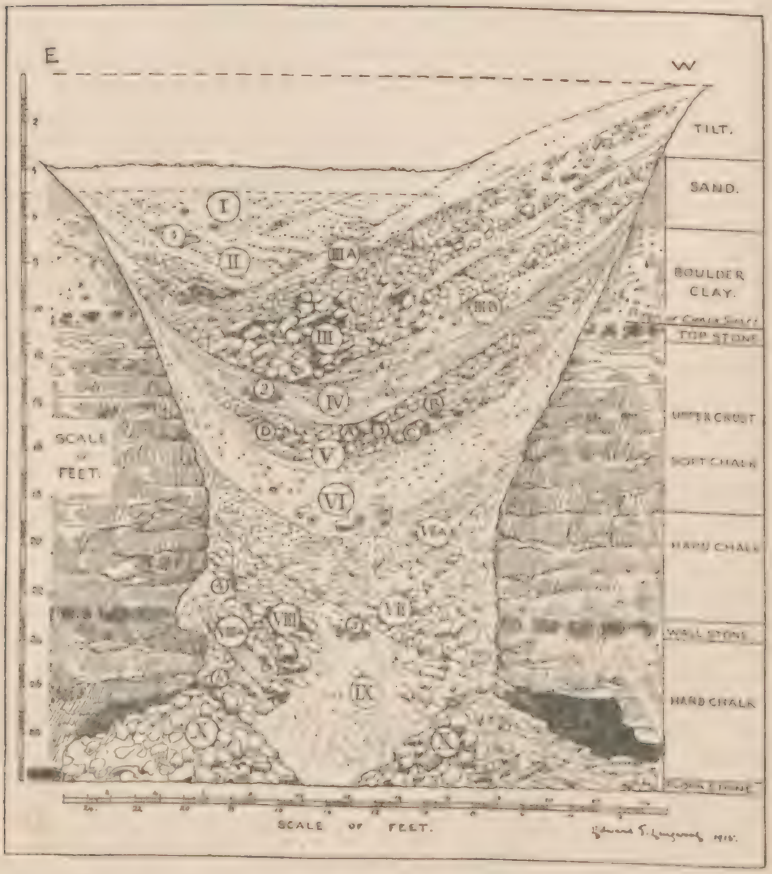


Fig. 2. Section of Pit I. Drawn by E. T. Lingwood.

DETAILED DESCRIPTION OF THE LAYERS OF PIT I. AND THEIR CONTENTS.

In this account only a few of the most notable implements are referred to, the full description being given in Mr. Reginald Smith's report. For the full list of bones identified see Dr. Andrews' report.

Layer 1.

This consisted almost entirely of rainwash with a maximum thickness of $3\frac{1}{2}$ ft. It is impossible to estimate the rate of deposit. The surface of the pit presented a cupped appearance, but the section shows that this layer was very thin on the west side. It would seem that the pit after it was abandoned as a dumping ground was left with a sloping surface, deepest at the east end. The levelling influence of the rain converted it into a cup. This layer was composed of sandy rubble, with a few chalk blocks and top-stone nodules. It was dark above, where the needles and cones of pine trees had accumulated. It contained quantities of chipped pieces mostly at the bottom of the layer, white on both faces, and similar to those on the surface of the Graves. The bones found were very fragile, and perforated by plant and tree roots. Most of the bones consisted of parts of the skeleton of a horse, and lay in the N.E. section near the middle line. The upper and lower jaws with teeth in situ and portions of the skull were found, in a fragmentary condition. A few pieces of red deer-horn and charcoal were with them. The implements included an end scraper (Fig. 19), a flat-faced adze of which we afterwards obtained other examples, and which formed the commonest type found by Canon Greenwell—a fusiform and a flat-topped cone, some large choppers, a fine disc, and two pointed ovate implements of drift type. Some of the topstone nodules had been partly worked. A small flattened quartzite pebble was found 2 ft. below the surface, battered all round the edge as if used as a hammer, and similar to some found at Peppard. About 25–30 good implements came from this layer, and the roughly chipped pieces filled a large wooden case.

Layer 2.

This consisted of small loose dry chalk rubble which had apparently been split up by frost, with a maximum thickness of $2\frac{1}{2}$—3 ft., at the base of which chalk blocks were lying at an angle of rest. It was a small tilt which was thrown in from the East and N.E. sides and lay on layer 3. It was mainly confined to the N.E. and S.E. sections. As in layer 1 the base formed a V in section. Some of this dry rubble extended towards the West, and must have come from that direction as the top of layer 3 sloped to the East. In this rubble were bushels of shells, the most obvious being *Helix nemoralis* or *hortensis*, and *Pomatias elegans*, the latter as is usual mostly having the operculum attached. The mass

of chipped débris extended into this layer as did part of the skeleton of the horse. The pieces were not so deeply patinated, but came out blue, turning white on exposure, or, more correctly, on drying, the edges being sharp. Two hammers were found in the rubble, one of quartzite, used at the end and round the circumference, and a flint ball about the size of an orange of the type frequently found on the surface, notably at Peppard and Hambleden, Bucks. These were 4 ft. D. below the surface. Some good implements came from this layer—an ovate, very similar to one from Peppard, a rounded engrailed scraper, with steep work at the bulb end, a one-faced cosy, a fine thick disc, and an end of celt. All this chipped refuse with the hammers suggested that the edge of the pit had been used as a chipping area.

LAYER 3.

This layer consisted of large chalk blocks, some of them measuring 1½—2 ft. square. They were shot in from the West and were encountered as soon as we commenced to dig on that side. The blocks lay at an angle of 20°. As we extended the trench from West to East it was seen that the blocks had slid over each other until they attained an angle of rest. For the most part they had no matrix, but between the blocks were quantities of shells, either empty or filled with chalk, and those from the surface of the layer with sand. This mass of blocks attained a maximum thickness of 5 ft. In it were some pieces of floor flint, identified subsequently by one of the knappers from Brandon, showing that the whole "tilt" came from the galleries of another pit, at that time open. Most of the pieces from this layer were blue, turning white, and were largely covered with a white fungoid growth. The upper part of this layer consisted of a band of sandy rubble, 1—1½ ft. in thickness (3 A), difficult to move with a pick-axe, and almost as tough as cement. It probably indicates a period of exposure to rain and, perhaps, frost. A band of sandy clay ran through the middle, and another similar to that above (3 B) rested on the top of the black band, both 3 A and 3 B perhaps representing sandstorms. The implements from this layer were mostly at the top, notably a long thick celt (Fig. 24), from 3 A, not of floor flint, with a battered wavy edge, and a fine disc. A slender dagger chipped on both faces (Fig. 23), and four hammers also came from here, one of the latter being a large coated nodule, whilst two others were of quartzite, one with a flattened depressed face. A rough adze came from 10 ft., a large-pointed ovate from the same level below the cut edge. Amongst the blocks were quantities of roughly chipped pieces irregularly split, all of a deep blue colour, evidently the waste in the making of implements. In examining the flint from the various layers and galleries one of the Brandon knappers informed me the pieces were useless, as they showed irregular fractures, and would be cast aside at the present time, and this explains the apparent wastage on all these mining sites.

At 10½ ft. D. I found a block of chalk in this layer, which had one face rubbed smooth and somewhat hollowed. Most of the bones from this layer presented a curious yellow appearance which suggested they had been boiled. No other bones were in this condition.

THE BLACK BAND.

Layer 4.

This consisted of chalk rubble and a mass of charcoal 1–1½ ft. in thickness. It was somewhat cup-shaped, commencing just above the level of the chalk lip. It is well shown in the section. Its distribution was somewhat peculiar. It extended to the E. and W. sides of the pit, and also to the N. edge where it was joined by a small fan-shaped tilt or fall of dark soil 1 ft. in thickness, which commenced a couple of feet above it. The band did not extend all over the pit but was absent from the N.E. and N.W. sections for a space of 6 ft. from the wall of the shaft, these spaces being occupied by boulder clay and sand. On the S. side where there was a great tilt of sand it only extended for 2½ ft. from the middle line. In the S.E. section a definite hearth was exposed 10 ft. below the surface composed of six large fired flint blocks massed together, and close beside it a large piece of burnt red deer-horn and some burnt flakes, and a lump of wood charcoal. It is clear this level was used as a habitation when the pit was 14–15 ft. deep. It was occupied for some time, as an accumulation of 1–1½ ft. of charcoal took place. The people left behind them a number of good implements, the best being the long celt (Fig. 26), which came from the base of the layer near the east end, and about 6 ft. from the hearth, 10 ft. D. A round-ended adze with diamond sectioned handle (Fig. 25) was near it, and from the same layer came two discs, an oval knife, a flat-edged adze, and a quartzite hammer in the N. section. From this layer, too, came a block which looked like ochre. At the base was an accumulation of dark blue flakes, which formed a great contrast to the small thin ones which lay on the sandy edge.

Layer 5.

This was composed of large chalk blocks shot in from the west, which commenced 8 ft. below the top of the mound, 2 ft. above the chalk lip, and reached 16 ft. S. Across the centre of this layer ran a hard thin layer of mixed sand and rubble, evidencing an interval between the tilting in of the two parts of this tip and suggesting again a sandstorm which prevailed after the lower half was thrown in. Scattered through this layer were some fine implements, notably a dos abattu knife, blue-black in colour, several choppers, and a fine thin disc (Fig. 28) which occurred at 12 ft. D, and near it a core used as a hammer. Three other hammers were found near the bottom. At one spot buried between the blocks was a pocket of large black flakes and an ovate implement, blue and sharp (10½ ft. D), and scattered through the whole was a quantity of mined flint and

roughly chipped flakes. From this layer came the first undoubted deer-horn pick marks on some blocks of chalk at 12 ft. D. The human skull too came from this layer, and the circumstances under which it came to light are now described.

THE HUMAN SKULL.

As I have mentioned, for convenience of recording the finds, the pit was divided up into four sections by imaginary lines drawn from north to south, and from east to west. On March 11th we were still throwing out by stages. Three parts of the pit, viz., the N.W., N.E., and part of the S.E. sections had been cleared to 14 ft. S., *i.e.*, 10 ft. below the cut edge. A stage was built on the S. rim of the encircling mound, and another one 3 ft. lower on the top of the tilt in the S.W. part of the pit. This latter mass, made up mostly of large chalk blocks (layer 5), was gradually diminished until we cut into the sandy layer to the S. and W., which here formed a thick column running down the side of the pit. It had filtered in between the blocks of chalk, above which part of the black band was still seen. On cutting away layer 5 we noticed just before lunch a piece of bone wedged in between the blocks in a part of the tilt which lay beneath the stage. It was not until the afternoon, however, we were able to reduce the blocks in front and find out it was a human skull. (Plate IV., top.) It was a damp day, and the light was bad for photography, and we at first thought of leaving it until the morning. However, as we were having sharp frosts and the blocks beneath the stage were not in a very secure state, in consultation with Mr. E. T. Lingwood it was decided to remove it to a place of safety. On clearing away the blocks the position of the skull was seen. It was wedged in between several large chalk masses on the margin of the big tilt (layer 5). At this point the sand had formed a matrix for the blocks and filled the interior of the skull. Close beside it were flakes and roughly chipped pieces. It lay partly inverted with right temporal bone partly detached, the long axis being S.E. by N.W. The whole of the base was gone, and the occipital bone completely detached. The frontal bone also lay a little apart. It was 10 ft. 8 in. below the cut edge (14 ft. 10 in. S.), 8 ft. from the east edge, 7 ft. 9 in. from the west edge, and 10½ ft. from the north edge, 12 ft. 7 in. below the dark line of sand previously mentioned which appeared to be the surface at the time of the mining. The black band lay 18 in. above, and a large piece of split shaft of a long bone (identified by Dr. Andrews as ox) was 2 in. below a piece of chalk separating the two. The rest of the sand and chalk were carefully examined, but no trace of the rest of the skull or other parts of the skeleton were found. The position of the skull, wedged in between the chalk blocks, shows that it was thrown in with the tilt, and the presence of floor flint in this layer proves that it is not later than the mining. The absence of the rest of the skeleton suggests that an old grave was disturbed by the miners in sinking a new shaft.

A detailed description with diagrams is given in the report on the human remains by Prof. A. Keith.

LAYER 6.

As will be seen from the section this layer formed a cup from east to west. It was divided into two layers, the upper part of sand, the lower part of boulder clay. As is described under a former section the latter formed our guide in deepening the N. sections as it appeared to be in situ. In order to show the condition of this layer it is well to mention that the foreman, who is accustomed to dig wells in the neighbourhood and to judge whether material has been previously moved, was convinced this layer was in its natural condition. The boulder clay in this district differs from that of Ipswich with which I am most familiar, and until it was identified as mentioned previously, I thought it was a rain wash which was formed by the amalgamation of chalk rubble and sand which had been washed down from the layers of the mound above. It was seen subsequently above the chalk by Prof. Kendall, of Leeds, who pronounced it in situ at that spot. The importance of this layer across the pit has been referred to. From the lip of the pit and covering the boulder clay at the sides of the shaft we encountered a considerable amount of sand. This formed a layer of variable thickness all round the edge and was continuous with the unmoved sand above the margin of the chalk shaft. A good deal of this no doubt had fallen in from the sides, but in certain parts it formed large fan-shaped masses, especially noticeable in the N.W. and S.W. sections. In the former it measured 6 ft. across at 13 ft. S., and in the latter, 12 ft. across at 8 ft. D. where it was 3 ft. thick. The thinnest part of the sand was in the N.E. and E. parts. When layer 5 had been cleared out we had a complete red sandy cup encroached upon by the two big tilts mentioned. This ran up the sides of the shaft and was only capped in the surrounding mound by chalk rubble, below which was the darkened surface previously mentioned. A large quantity of chipped material from this surface had dropped into the pit, especially at certain points, viz., at the E., W., S., and N.W. edges, and lay partly buried at various levels. We concluded from this that the surface at the time of the mining was sandy, and that the pockets of chipped materials found in the spots mentioned were the refuse thrown down by the workmen who sat on the edge of the pit and chipped their implements—before the pit was used as a dwelling place at the time the black band was formed. Some good pieces were dropped in that way, notably two good discs which were near the east edge, a dos abattu knife with alternate flaking on the ridge, a square-ended bevelled adze with one unworked flat edge (of which duplicates were found), a fine chopper which came from the N. section of the pit 7 ft. below the surface, an engrailed scraper 8 ft. D., and a long implement with steep endwork found by Mr. E. T. Lingwood in the N.E. corner, 12 ft. below the surface. It was in order to see if this dark sand representing the living

surface was present elsewhere that a trial hole (Section 8) was dug in a flat space to the E. of our pit between a group of pits.

The deeper parts of the sand contained thermally fractured flints but no chipped pieces. The lower part of the layer now being described consisted of boulder clay which formed a tough coating to the chalk shaft continuous with the same material above. The thickest part was in the centre of the pit (3 ft.), and it thinned out on the N. side where it joined the same material which there lined the chalk wall. On the south it united with the great tilt of sand which ran from the surface and filled up so much of the S. and S.W. area at this point. Beneath this sand the boulder clay also lined the chalk shaft. If this were continuous across the pit at this point, its decalcified condition beneath the column of sand is easily explained as water would freely percolate from above and gradually remove the chalk from the original layer. No chipped pieces came from this layer, but as previously mentioned a large number of flint nodules, including "floorstone," lay at the bottom in the centre extending into the chalk rubble below, and partly buried in both was a fine red deer antler. Sand from this layer extended down the centre between the blocks of layers 7 and 8 and united with layer 9, reaching the bottom of the pit. No shells were found in the boulder clay and only five came from the sand above it.

Layer 7.

This and No. 8 occupied most of the lower part of the pit. The former consisted of fine chalk rubble with blocks below. It was not all one tilt, but came in from the W., S.W., and S. sides. The western part was divided by a thin layer of red sand, ½—1 ft. in thickness, which ran at 30° from the edge, commencing at 16 ft. S. for about 6 ft. into the pit, and then died away. This may represent a fall of sand in an interval between two "tips." At the sides it reached 15 ft. S. The whole was marked by very few shells, only three *H. nemoralis* being found, in marked contrast to the layers above. Floor flint and nodules of topstone were scattered through the chalk. No bones were found in this layer. An interesting chipped piece resembling a broken end of celt was found, having a portion of the base battered as if to get rid of the sharpness and adapt it to the hand. Similar pieces came from floors 12 and 13. At 20 ft. S. a large ball hammer was found. Most of the chipped pieces were of the roughest description, unsymmetrical flakes and partly worked blocks, unpatinated, and with sharp edges. It contained a number of deer-horn picks.

Layer 8.

As in pit 2 the whole of the lower part of the pit was filled with large chalk blocks in which were buried numbers of deer-horn picks. In pit 2 two layers were traced, whereas in pit 1 three layers were detected, viz., 7, 8, and 10. We cut into this layer at 19 ft. S. on the east side, and found eventually that the blocks

were thrown in from the E., and to some extent from the N. As in layer 7 a small band of sand (6 inches thick) divided this layer, and extended for 5 ft. into the pit. The blocks were of tabular chalk and came from the bottom of a pit or gallery, some measuring 1—2 ft. in length, and isolated fragments of charcoal were scattered between them. Many had marks made by a deer-horn pick. At 25 ft. S. a piece of flint was found resembling an Eolith, and a sharp-pointed ovate implement chipped on both faces. At 24 ft. S. were some large flakes which were black when taken out but turned faintly blue when dry. Several large pieces of floor flint and one good flattened disc and a large rounded nodule used as a hammer, estimated to weigh about 10 lbs., were found at 27 ft. S., the latter being 2 ft. from the N.E. edge.

At 27 ft. S., just under the arch of gallery 1, were observed what appeared to be pieces of dark clay. These proved to be pottery, very soft and coarse—the first pottery found at Grime's Graves. Other fragments came from the shaft, 2 ft. from this gallery, and a few more from opposite the N.W. buttress. Just over the head of gallery 8 was found part of the skeleton of a mole and a number of deer-horn picks.

LAYER 9.

This consisted of a cone-shaped mass of tough sandy rubble, almost as tough as cement, which started from the base of the N.W. cove of wall stone at 23 ft. S., and came in from the N. and N.E. Part of it followed the wall of the shaft and covered the head of gallery 2, and in that way preserved the rope marks observed here. It filled up the entrance of the gallery and covered over the chalk blocks, layer 10. The rest of it spread out over part of layer 8 and joined the sand which had filtered down the centre of the pit from layer 6. It contained surface-patinated lustrous blue and white flints. All the chipped flints from this layer were unchanged with sharp edges. Resting on it at the commencement and partly on the blocks of No. 8 were the remains of a fire (No. 2 fireplace). The sand here was reddened. A few horns were partly in this layer, but no bones.

LAYER 10.

This also was made up of chalk blocks and rubble, which from the lie of the blocks formed a layer distinct from Nos. 7 and 8. The part beneath the sand of No. 9 was thrown in from the N. and N.E., or piled in the floor of the shaft from a gallery. It was limited to the lowest 4 ft. of the shaft. In it were the remains of three fireplaces at different levels, viz., 27 ft. S., 29 ft. S., and 30 ft. S. (on the bottom of the shaft). No. 3 fireplace, 27 ft. S., was 6 ft. from the S. side of the entrance to gallery 1. There were no large flints as in the black bands but a mass of charcoal, which included a piece of charred log. This was in a fragile condition and came out in pieces, but was measured *in situ*, and proved to be 1 ft. broad and 6 in. thick, and is interesting as it shows that

trees were growing in the neighbourhood. Beneath this fireplace lay a crown of 3-4 tines, and several separate ones. 1 ft. below lay part of a rim of pottery, black like the last and red outside. It was thin and smooth without ornament. One of the largest blocks of chalk came from this layer. It measured 1 ft. 8 in. by 8 in. The men called it "Grime's Tombstone." Other fragments of pottery were found in the sandy rubble at the entrance to gallery 6. One *H. nemoralis* came from 26 ft. S., and another from near gallery 7, the only ones at this level. Fireplace No. 4 (29 ft. S.), was 5 ft. from the west edge, and was composed of charcoal, burnt sand and chalk, and with these were some dark chalky pieces which had the appearance of worm casts. The large rib (red deer) previously mentioned came from this layer (29 ft. S.) It had a cut on it possibly made by a flake. Fireplace 5 was on the floor of the shaft 5 ft. from the S. point. It was similar to the others. A number of interesting flints came from this layer. At 27 ft. S. was a wedge or tortoise core, which had been subjected to fire, and had a cutting edge suitable for chopping. Another somewhat similar had signs of use on one edge. It came from the entrance to gallery 8, and near it was a group of black flakes, and a large pointed block which looked like an axe roughly blocked out. One long flake quite unpatinated, as were all these pieces, lay near this group, and bore signs of use at the end. One group was close to the south buttress, and the other near the north one of gallery 8-10. Quantities of waste "floor" flint and a disc patinated blue also came from this layer, the latter evidently exposed for some time before it got into the pit.

THE EMPTY SHAFT AND THE ORDER IN WHICH IT WAS FILLED BY THE MINERS.

On looking into the empty shaft (Plate III., bottom) one sees it is nearly circular. The upper part has a batter, that is to say it is broader above and narrows as it gets deeper—in other words it is funnel shaped. The lower part is vertical. The former corresponds with the soft chalk, the latter with the hard tabular layer. At the top of the mound it measures 32 ft. by 32 ft. The chalk lip can be traced all round and above it is boulder clay, sand, and chalk rubble. A layer of flint is seen projecting above the chalk and another (upper crust) 4 ft. below, whilst the line of the vertical wall is broken 7 ft. above the floor by five little coves or recesses, three of which are grouped side by side in the N. wall. In the base of each the wallstone layer is seen with some chalk removed below it. The floor of the pit is seen to be flat, and the shaft here has a diameter of 12 ft. by 11 ft. Projecting into it E. and W. are two large buttresses. A prominent feature in the north wall is a

Pit 1 from the top.
(From a drawing by E. T. Lingwood.)

hole cut in the chalk just below the lip. (Plate V., top). It measures 2 ft. in depth, 1 ft. across, and extends for 1 ft. into the chalk. Beside it a foot to the west is a pyramid of flints resting on the chalk and evidently placed there by hand. On the south side is an indication of a similar contrivance, probably to keep a beam in position. At the bottom of the shaft the wall is seen to be pierced with seven openings, six of which are the entrances to galleries, the remaining one being an inlet for air into gallery 2. These entrances are seen to vary in height, that of No. 2 (Plate IV., bottom) on the N.E. side of the shaft being the highest, if we except the common entrance of Nos. 8 and 10 (Plate V., bottom) on the east side which has fallen away. One can see, too, a portion of the floor flint projecting from the wall between galleries 1 and 2 on a level with the floor. It is possible by means of the key afforded by the layers filling in the pit to recount with some degree of accuracy what took place after the mine was worked out at this spot.

As is mentioned under "The Galleries," just before the shaft was abandoned only one small portion of the area was being worked, all the entrances being blocked up with the exception of Gallery 1, and as this was the last part of the mine in working order it is probable that the piles of chalk on the N., W., and N.E. were brought out from this gallery and formed layer 10. The three fire-places in the lower part of the shaft, only one of which was on the floor, show that the pit was not quite clear at the end of the mining. The single tines and cup ends of horn found near them point to the kindling of fires for the manufacture of picks used in the galleries. It is somewhat singular that no food remains such as bones were found in this part, and the absence of these is suggestive. If the fauna is of the same date as the mines, and it seems difficult to doubt it as the bones were in many cases between the chalk blocks, the diet of the miners would include wild animals such as roe and red deer, and the various domesticated animals mentioned, together with milk. The absence of animal remains at the bottom of the shaft rather suggests that their diet also included cereals, of which no remains would be found. It is, of course, possible that they quitted the shafts at meal times.

Just about the time the mine was abandoned a fall of sand took place (layer 9) which covered up the blocks piled upon the floor. This might also be a small tip thrown in from the N. when a new pit was being started. A fire had been kindled for making picks at the top of this 6 or 7 ft. above the layer, and as this lay partly on layer 8 which filled up so much of the lower part of the shaft it would seem as if the pit was still used for this purpose after it had ceased to be worked as a mine. When it was definitely abandoned the shaft was used to get rid of a great mass of chalk from the galleries of a pit on the east and north, which if piled on the surface would have encumbered the spot. 8A is a fall of sand which occurred at this time. From the account of the galleries it will be seen that two pits at least were open to the S.E. and N.W. at this

time, and most of this layer may have come from this area. The rest of the pit below 18 ft. S. was filled up with soft chalk which did not come from a gallery but from the upper part of a shaft. This was shot in mostly from the W., S., and S.W. directions, and perhaps indicates the digging of a new pit. A slight fall of sand also divides this layer. On the top of this came in the layer of boulder clay, the upper part of which became decalcified and formed the layer of sand on its surface; whether this was washed in, tilted in, or introduced as the result of glacial action is not quite clear. It should be remembered, however, that in digging a new shaft a considerable thickness of boulder clay would be removed and had to be deposited somewhere out of the way. That new pits were being opened at this time on the N. and S.W. is fairly evident from the columns of sand which occupied the pit in those directions, though to some extent this may have been derived from the cutting of a gangway between two neighbouring shafts. At this time, too, a good deal of sand came in from the edge all round. The blocks of No. 5 came from the lower part of a shaft or gallery on the west, perhaps one of the three pits worked together in one hollow. It is possible that the human skull which was wedged between these chalk blocks belonged to a miner who was killed in the galleries of an adjoining shaft by a fall of the roof, but it might equally well have come from a disturbed grave and been thrown in with the blocks.

The layer 5B points to a great sandstorm which temporarily stopped the work of throwing blocks into this pit. This could not be rainwash as the surface below consisted of chalk blocks without any matrix, and a wash caused by rain would have filtered down into the cavities and not run as a definite layer towards the centre of the pit. The partly-filled shaft was then clearly used as a dwelling-place for a considerable time from the thickness of the charcoal found there. A hearth was made of large flints, the flesh of domesticated animals (ox and sheep) was cooked on the spot, and the work of chipping implements and making deer-horn picks for use in the shafts and galleries carried on. A dumping ground was required, however, for the chalk which had accumulated in a neighbouring shaft to the west, and after a possible interval 3B marked either by sandstorms, or in this case prolonged rains, the abandoned habitation was covered in with chalk blocks and waste flint, thrown in at two periods, as the blocks are separated by the layer of clay. The top of this tilt was covered by another layer of tough sandy rubble, evidently a period of exposure of some duration as it was 1–1½ ft. in thickness. This again is perhaps the result of a sandstorm from the west. Some blocks were thrown in from the east on the top of this large mass, those above being broken down by exposure. The pit was thus left about 5 or 6 ft. deep, possibly less, as the material would settle down in the course of time and a good deal of the chalk become dissolved. So it remained, as about 3½ ft. of sand and chalk was gradually washed in by the rain and formed the cupped surface through which we cut.

NOTES.
Deer Horn Picks indicated thus.
Polished Axe marks on walls. —— ⋀
Pottery indicated thus. —— ※
Flint implements. —— ×
Bone implements. GALLERY. I —— +
Animal bones, as below, indicated— ⊕
GALLERY. I & V Beechstein's Bat. — Three.
GALLERY. II XII Bat skeletons. — Two.
GALLERY. VIII Natterer's Bat. — Two.
Mole skeleton.
GALLERY. X. XII. XIII & XV. Field Vole.–Four.
GALLERY. XV Red Deer. Long bone, part skull, lower end of tibia artificially hollowed.
Tines & first year Deer horns, indicated.
PIT SHAFT No. 1.
PIT SHAFT No. 2
PIT SHAFT No. 3.
PIT SHAFT No. 4.
See the Plan of Graves Fig. 1 for surface position of shafts marked hereon.
PIT SHAFT No. 5.
SHAFT OF PIT
Floor 50-0 below surface level.
Blocked Solid Termination uncertain.
Termination uncertain. Probably connects to Shaft 2
Outline of shafts Nos. 1 to 5 is only approximate.
Unexplored. Blocked solid.
Unexplored. Partially blocked.
Unexplored. Blocked solid.
Unexplored gallery.
Unexplored. Partially connected to XVI & XXVI
Unexplored. Blocked solid.
Unexplored. Blocked solid.
Unexplored Gallery. Blocked solid.
Loosely filled.
Talus of sandy rubble.
Blocked
Partially filled roof low.
Filled with loose rubble up to 9' below roof.
Filled solid with loose rubble & blocks.
Filled solid with compact rubble up to roof level
Implement
Air or light
Blocked creep.
Fairly open with hard rubble floor
Smooth axe marks. (Cast taken)
Vole skull & bones
Flint in situ.
Bat bones
Axe marks. Cast taken
Partly filled
Pottery
Quite open
Pile of mixed flint.
Part filled
Filled with loose rubble & blocks.
Fairly open of coal, floor exposed, flint in situ & mined.
Entrance walled up with blocks
Filled up to 6 inches below roof level.
Talus of filling.
Lamp.
Entrance built up with blocks
Light or air
Part skeleton of Field Vole
Built up with blocks.
Part Red Deer skull & tibia
Axe marks
Bat skull & bones.
Pairly open
Blocked solid to roof
Talus
Air hole.
Filled to 9 inches below roof.
Deep rope or thong grooves on lintel.
Entrance blocked.
Light holes
Talus of filling.
Axe marks. Casts taken
Flint in situ & blocks on floor.
Carved chalk
Open in centre
Flint in situ.
Entrance clear.
Entrance blocked
Axe marks
Filled solid.
Fairly open.
Walls oxidised
Flint in situ & in place.
Bat skeleton.
Shaled marks probably of chipped axe.
Field Vole skull
Centre open, sides piled with large blocks.
Blocked
Filled solid
Filled with loose rubble
Talus of sandy rubble.
Fairly open
Unexplored. Blocked solid.
Unexplored. Blocked solid.
Fairly open
Unexplored. Blocked solid.
CHALK.
CHALK
CHALK.
TABULAR "FLOOR FLINT."
TABULAR "FLOOR FLINT."
TYPICAL GALLERY SECTION
Centre open, sides piled with rubble.
GRIME'S GRAVES EXCAVATIONS
1914
PLAN OF GALLERIES FROM PIT No. 1
SCALE OF FEET.
A. LESLIE ARMSTRONG F.S.I. SURVEYOR. SHEFFIELD. 1914.

FIG. 3.

THE APPEARANCE OF THE GALLERIES WHEN FIRST ENTERED.

In this section I shall describe the condition in which the galleries were left by the miners, and from various facts try and show how the mine was worked.

Gallery 1. (Plate VIII.).

It was an exciting moment when we were able to obtain the first glimpse into this gallery, only equalled later in the same day when we actually entered it. Since Canon Greenwell's work very many new discoveries have been made, which seem to show that the various phases of the stone ages were of far longer duration than was at first supposed. A conservative estimate for this mining is perhaps 5–6,000 years. Prof. Sollas gave the wide latitude for the contemporary industry of Peppard of possibly 20,000 years, and the whole culture is placed at more than 200,000 years by Dr. Allen Sturge. We could not, therefore, fail to experience a certain amount of awe when for the first time we re-entered the old workings. On shining an acetylene lamp into the mouth of this gallery it was seen to be partially open, the blocks from the talus down which we were looking having rolled only a little distance on to the open floor. Just to the left of the opening was a mass of flint, piled up by the miners, and beyond we could just discern three deer-horns lying in a straight line. The entrance measured 3¼ ft. across and 2½ ft. in height. (Plate VII., top.) It was thus only possible to get inside by crawling. The floor of the gallery was found to be of chalk rubble beaten down hard, with blocks of chalk and flint scattered over it. We found ourselves in a low chamber in which it was impossible to stand upright. Immediately facing us and blocking up the rest of the gallery was a mass of chalk blocks extending to the roof. Between this and the entrance lay the deer-horns. It was somewhat singular that these were in a straight line, and though this may have been accidental, one is inclined to think they had not been carelessly thrown aside, but placed carefully in that order. The centre piece was not a pick, but the expanded end of an antler with the tines intact, some of which showed signs of use. It was in a very fragile condition, and broke to pieces as soon as it was touched. The pick to the left was of a slain deer, and that to the right a shed horn: the latter had been gnawed by a rodent at the end of the brow tine, and the fragments were seen on the floor below. A closer examination of the floor brought to light the skull and lower jaw of a bat with bones of the skeleton, which lay beneath the S. horn, and some shells which are referred to in the special report. The soft rubble floor was found to be ½–¾ in. in thickness, and contained quantities of fine sharp fragments of flint entirely unpatinated, evidently the debris caused by splitting up the flint extracted from the chalk. A cut tine was buried in the floor. Flashlight photos were taken of this gallery. (Plate VII.,

middle and bottom.) The rubble partly filling it was found to contain a quantity of sand in which were lustrous white patinated flints with thermal fractures. They had evidently come in from the surface, and were thrown into the gallery by the miners after acquiring both patina and lustre. Charcoal was scattered through the rubble, and some small pieces of pottery were found in the spots indicated on the plan. Behind the wall of the shaft, here 2½ ft. in thickness, a line of floor flint was seen, not a continuous layer, but in isolated nodules. The four air holes seen in the plan were entirely hidden by blocks. The chalk was piled up in this gallery above the top of the creep hole at the end, and this was consequently done from the S.E. side. It seems likely that this was the last gallery worked in this pit as it was left partly open, especially as some of the floor flint was piled up ready to be taken to the surface. (Plate VII. bottom.)

GALLERY 2. (Plate IX.)

Access to this was obtained by Mr. Armstrong and myself on March 25th through the creephole from No. 1. That these small square holes through the walls of the galleries were never intended for transit was forcibly brought home to us. We found ourselves in a higher gallery which ran to the left. A pick lay across the air-hole through which we entered, and the gallery to the right, No. 4, was packed with chalk to the roof. Three fine picks were close to the opposite wall, only partly buried in rubble. The mouth of this gallery was filled up by a mass of tough, very sandy chalk, which had come down the shaft wall. It is clear, from the chalk found in this gallery, it was not being worked at the last. A good deal was in the entrance, and a large mound in the centre of the gallery. The whole of No. 4 might have been filled from this direction. The entrances of No. 3 and 18 were only found by taking away the blocks. This part appeared at first to be a wall. These were also filled from No. 2.

GALLERY 5.

This was first found by Mr. Armstrong on March 27th by clearing a passage through No. 4. On looking through the creep-hole it was seen to be partly open, and to be a rounded chamber, about five ft. high. A large talus of chalk and sand faced the entrance, covering the floor to some extent. An open apse was seen to the right where the flint was *in situ*, and a heap of it lay in the corner. In the sand were patinated lustrous flints without human work, and it was at first thought this sand had been carried into the gallery. Subsequently, the living roots of trees were found here, and the proximity of a shaft was certain. Just inside the creephole lay a pick, another lay on the talus to the left, and three more were partly buried to the right. Mr. Armstrong subsequently found an unpatinated rough implement with a steeply chipped face between the blocks.

Gallery 1, Pit 1—(Top) Entrance.
(Middle) First peep into Gallery from the shaft, deer-horn pick and upper portion of antler in foreground.
(Bottom) Pile of mixed flint blocks on left side of entrance, as left by original miners. (Photos by A. L. Armstrong.)

Interior of Gallery 1, Pit 1.
(Flashlight Photo by "Prehistoric Society of East Anglia.)

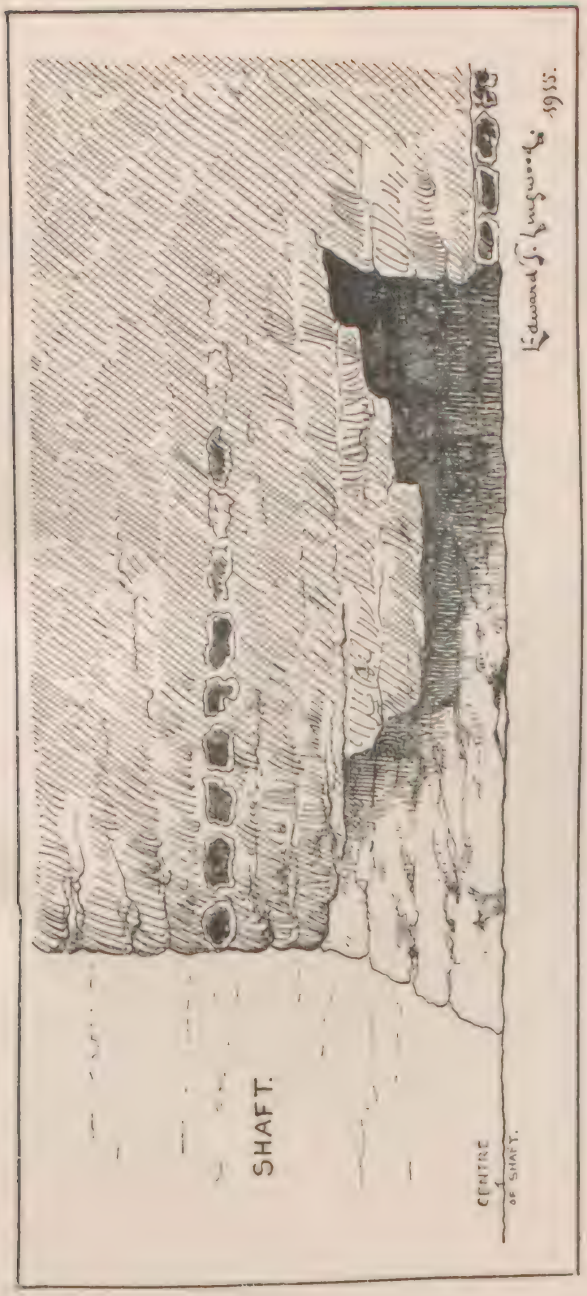


Fig. 4. Section of Gallery 1, Pit 1. Drawn by E. T. Lingwood.

GALLERY 6.

The entrance was low, only 3 ft. in height, and blocked with a tough mass of sandy rubble which extended for some distance in the gallery and rose up beyond the top of the entrance. It was consequently thrown in and was not a tilt from the shaft, and some form of shovel or basket would be required for this. When this was cut through it was possible to get into the partly-open gallery and reach the air-hole to the left. The wall here was extensively stained with iron, and had the appearance of red fresco work. In the rubble near the S. wall I found a carved chalk cylinder with three squared sides.

GALLERY 7. (Plate X.)

This was entered on March 28th through the squared hole from No. 6. It was partly filled. Two picks lay in the chalk, in a very fragile condition. The whole of the far end was blocked by a mass of chalk, but the portion near No. 6 was open except for a few blocks. The talus covered the walls at the sides: where these were open numbers of deer-horn pick marks were seen, but no others. This gallery was clearly filled from No. 12, which formed part of the system of shaft 5.

GALLERY 8.

When entrance was first obtained to this gallery on March 28th it was thought that only one gallery lay in this direction. It was entirely blocked for about 8 ft., and after that distance rapidly opened out until a long passage was seen, through which one could move comfortably. The floor was open in places, and the walls on either side had chalk blocks piled up by hand. After another 16 ft. the roof became lower and a square opening was seen 2 ft. in height. After passing through this a step, 10 inches in height, was seen to coincide with the opening, beyond which the floor was open, and at a lower level. The gallery was narrower here, with blocks piled only on the right side, the chalk wall being exposed on the left. Below this the flint was seen *in situ*, with an open rubble floor. Lying on this old surface was a fine deer horn pick and the bones and skull of a bat, the wall above being studded with deer-horn pick marks. Beyond lay a steep talus which, from the presence of sand, showed the base of a shaft was not far away. Mr. E. St. H. Lingwood subsequently found at the end of the gallery a massive T-shaped nodule of flint, which had been used at one end for hammering. This was the only flint hammer found in the galleries, and it is not at all improbable it was used to split up the nodules of flint extracted from the mine—though, as we have seen, deer-horn picks were mostly used for this purpose. It is interesting to note that Canon Greenwell also found in the galleries a hammer of flint described as resembling a "cat's head."

Inside Gallery 2, Pit 1, looking towards entrance from the base of the shaft, with air-hole on left. The Gallery on the right, partially blocked by chalk débris, is the common entrance to 3 and 18. (Flashlight photo by "Prehistoric Society of East Anglia.")

Interior of Gallery 7, Pit 1. (Flashlight photo by "Prehistoric Society of East Anglia.")

Gallery 12.

The credit of opening up this gallery is due to Mr. Armstrong, though Lieut. W. Hall contributed largely by clearing a passage through the solid mass of chalk blocking up most of gallery 7, with which it communicated. We entered this gallery on March 31st, and it proved to be so interesting we did not emerge into the shaft until it was dark. The lamps having given out, the ladder had to be negotiated under difficulties. This gallery was just as the men had left it, and had not been used to receive chalk from other parts of the mine. It was part of the system of shaft 5, as is described later. At the bottom of the talus, filling up No. 7 gallery, lay a pick, and two or three others were found partly buried. A fine one lay on the rubble floor beside the flint which it had no doubt been used to extract. This was at the N.W. end, where it expanded to form an apex. The wall here was marked by deer-horn picks, but there were also other marks which were not made by this implement, and unlike anything seen elsewhere. These marks were on the chalk above the floor flint, and were slightly concave, 1⅛ in. broad. On the surface of each were three parallel scratches running in a longitudinal direction. Twenty of these were counted at this spot. Some of the blows had been delivered from the side and others from above. They were certainly not made by a polished axe, but might be the record of one like Fig. 26 found in the black band. In this gallery Mr. Armstrong found a piece of chalk with three marks that fitted the pointed end of this axe. This gallery varied in height from three to five feet, and was fairly constant in width, viz., 5 ft. In parts the rubble floor was visible, and large chalk blocks had been piled up on one side, the other in places having a talus of soft chalk. Its total length was 33 ft. To the south it extended for 13 ft. beyond the entrance through which access was obtained and terminated in a talus, beside which was an apse with the floor flint showing. The creep hole into No. 19 was clearly seen, filled up from the other side, and a pick lay in the entrance. The day before I left the Graves, in removing some large blocks at the south end of this gallery, I found the one marked No. 20. The blocks here were unusually large, and when they were cleared showed the base of the shaft, in which were several picks and horns wedged tightly between the chalk and sand. Just beyond this talus was an open apse, with galleries entirely blocked, extending in either direction. In the apse were three fine picks, one of them with an old break.

Gallery 13.

This was also a very interesting gallery. It lay behind the wall of No. 2, and the creephole leading into it was uncovered by the men and proved to be 1 ft. 9 in. broad, and 1 ft. 6 in. high. On looking through one could see a large open chamber, with a steep talus at the back, above which was an open space. This talus was the result of working out the chalk in the direction of our

shaft, and when the wall could no longer be cut away with safety, the air-hole was made to allow ventilation. Consequently the end just beyond gallery 2 was open, and the floor flint and rubble floor seen just as the miners left it. At one spot in this floor quantities of sharp pieces of flint were seen, where a block had been broken, and a fine deer-horn pick was left with the end broken off. A vole skeleton, too, was found there. The roof formed a fine dome, and was well preserved: and it is possible the floor sloped upwards. In height the gallery was 2 ft. 3 in.—3 ft., and 5 ft. in breadth, the apse being 7 ft. wide. If cleared, this gallery would be in parts nearly 6 ft. in height. The floor flint seen here was not pure, but had grey patches, probably chert in it. It measured 7 inches in thickness. As will be seen in the plan this gallery was nearly 40 ft. in length, and an easy passage existed to the end, which proved to be the bottom of a shaft (3) filled with sand and chalk, through which living roots had descended. The larger blocks had in this gallery been piled up by hand at the side, except between the two blocked galleries 21 and 24, where a rubble floor and flint *in situ* were seen. I eventually cleared a passage round the margin of shaft 3 and got into a gallery beyond, No. 13. It proved, however, disappointing, as more than half of it was filled with chalk, and it contained nothing of interest, not even picks; nor could I find any marks on the walls except those of deer-horns.

All the other galleries were blocked for the greater part of their extent. No. 3 was found slightly open near the end, where it communicated with a short gallery which terminated in a shaft. Gallery 10 was also open for a short distance at the end, where it ended in an apse with floor flint exposed. It was here that Mr. Armstrong found the chalk lamp, which appeared to have been made by revolving a stick or pointed flint, or perhaps a deer-horn tine, in a lump of chalk.

GENERAL ACCOUNT OF THE GALLERIES OF PIT 1, WITH REMARKS ON THE WORKING OF THE MINES.

When the plan of the galleries is studied it will be observed that these radiate from the shaft like the spokes of a wheel in a fairly regular manner, but were not driven with any scientific precision. The ends of the galleries terminate in some cases in the bottoms of neighbouring shafts. Of these there are certainly four, and in all probability five. No. 1 shaft opens out of Gallery 5, No. 2 out of Gallery 11, No. 3 is at the end of Gallery 13, No. 5 at the end of Gallery 16, and at the end of Gallery 3 is the base of a shaft, No. 4, which cannot be part of shaft 2. Taking the rim of pit 1 (the pit excavated), indicated by the dotted line, as a base, the latter shaft is found to be 9 ft. away. This measurement is taken to the bottom of shaft 2. If the measurement were taken on the surface the two

pits would be only a few feet apart. The base of shaft 2 is 14 ft. from the rim of pit 1, and this again would be very close to pit 1 if the edges were measured on the surface, but shafts 2 and 4 must be even closer. It is unlikely, however, that this is the base of one large shaft, as it would have at this level a diameter of 24–26 ft., far exceeding any other pit. The top diameter of pit 1 is nearly three times that of the base, and the shaft included under 2 and 4 would then be over 70 ft. On looking at the plan of the Graves it is seen that on the west side is a large trefoil-shaped hollow, which certainly includes three pits, one of which is possibly shaft 2. The other (4), lying more to the N., is not one of these. There is on the surface a slight indication of another pit to the N., almost entirely covered over with the mound which separates pit 1 from the trefoil series, and it would seem that this is the surface indication of shaft 4.

The other shafts are not hard to identify. Shaft 3 which is 43 ft. away measured in the same way is the pit into which we tipped the material taken out of pit 1. Shaft 1 is 18 ft. away; and shaft 5, 22 ft. Both of these are shown in the plan. The series of galleries is divisible into two classes.

(1) The main galleries, which are fairly constant in width and height. These are apparently designed to allow two people to pass each other, and for the most part are sufficiently high to allow a man to walk with the body bent carrying chalk or flint in his arms or in a basket on his back.

(2) Small galleries cut out perhaps from a large solid buttress and having their main entrance to the shaft. Galleries 1 to 6 are of this kind.

The communications between the various galleries are seen to be of three kinds.

(1) Wide open doorways of about the same height and width as the galleries themselves.

(2) Creep holes, constricted openings through which it is easy to crawl. Examples of these are seen in the middle of galleries 8 and 12 and in the communications between 6 and 7 and 1 and 4.

(3) Smaller openings evidently for ventilation, though in the first instance they may have been spots from which a nodule of flint was extracted. These we designated air-holes. They were always on a level with the floor and rarely exceeded 10 inches in height, some being less. Examples of these are seen between galleries 1 and 2, 1 and 7, 4 and 12, 14 and 5, 8 and 16, and 7 and 17.

It is also quite clear from a study of the plan that the pit excavated by us communicates not merely by creep-holes, but by passages with the galleries attached to other shafts, and the map makes us realise what a wonderful place the whole area of Grime's Graves would be if the chalk were all cleared out. There would be no prehistoric sight in England to equal it.

In studying the plan of the mine it is seen that a large part of the S. area is unmapped, and it is somewhat singular that the galleries should extend for so short a distance in this direction. No air holes were found in the S. wall of galleries 9, 6, and the contiguous portion of 7, and we must conclude there is a thick wall of chalk in this direction unworked. Some of this area was worked from shaft 5 as the blocked galleries 17 and 26 show, and also those leading out of the apse 20. The N., E., and W. parts of the area were worked out completely as far as safety allowed. The main galleries of our shaft and those clearly attached to other systems can be picked out.

(1) Main galleries of our system :—

Galleries 7, 2, 4, 3, 18, 10, 16, and parts of 8 and 11.

(2) Main galleries of other systems :—

Gallery 12 is clearly attached to shaft 5, as are the blocked galleries close to its base, viz., 20, 26, 17, and 19.

Gallery 13 is also clearly a main gallery of shaft 3 and those leading out of it, viz., 21, 24, 22, and those beyond the base of the shaft, viz., 23 and 25, all belong to this system.

The three other shafts do not appear to have a system of their own in the direction of our pit. Shaft 2 had a doorway and an air-hole leading into part of galleries 8 and 11. Shaft 1 had a free passage into gallery 13 and some creep-holes through gallery 5 into No. 4. No system of radiating arteries can be traced in either case. To take the area on the west side. This had one doorway to the pit, or possibly two. If the wall of No. 9 were completely cleared it would be found that free access to the shaft could also be gained through this small gallery. As already mentioned, when this part was first entered one passage only lay open in a line with No. 8 gallery, and our impression then was that we had on either side solid walls against which chalk had been piled. When this was to a large extent cleared away, it was seen that the whole of this area was a network of small passages separated only by buttresses left to support the roof. And here it may be noticed that where the areas were completely cleared the long continuous walls seen in the plan disappear and are represented by isolated buttresses. It is possible if the whole were emptied we should find to a large extent a similar system. The W. line of gallery 12 appeared to be solid at first, but is now seen on the plan to be a succession of buttresses. The wall between 3 and 5 was not cleared on either side sufficiently to show if any low air or creep-holes pierced it, as was almost certainly the case.

Galleries 10 and 16 were worked from our system. The latter had a smooth broad roof which had not fallen, and from its breadth seemed to lead into an extensive area. It terminated, however, in a broad apse.

It will be remembered that this and 11 and 10 were entirely blocked up when we first entered, but a passage (8) lay open in the centre extending west through the creep-hole. It is clear that the three galleries mentioned were driven before shaft 2 was abandoned.

as a doorway and creep-hole were cut through the wall leading into that shaft from the end of gallery 11. A free communication must have then existed between these two shafts. But shaft 2 was abandoned first as the door was blocked when gallery 11 was filled in. Our shaft which lies to the east was open a little later.

The S. end of No. 8 was evidently driven from that side, otherwise a step would not have been left at the creep-hole, and it is somewhat singular that this should form a continuous passage to our pit. No work was going on in the W. direction at the time the mining ceased, as it was not possible without endangering the roof. Why a passage was left in the centre is not easy to determine, as the mouth of the gallery had been filled in for about 8 ft.

The N.E. and E. sections had three main passages opening into our shaft through gallery 2. As will be seen No. 2 curved to the E. and terminated at the S. as gallery 4, where a hole had been cut at the end of No. 12 to allow the free circulation of air. The system of ventilation is well seen at this spot where No. 2 and 4 freely communicate with the galleries round by means of small holes which could only from their size be for one purpose. Free communication with our system was kept up with shafts 1 and 3 through wide doorways.

Gallery 3 also led to the bottom of shaft 4, and 18 in the direction of shaft 3, but as it was almost completely blocked we had no time to follow it.

The S.W. area had one main gallery belonging to our system (No. 7). This had a very low entrance to our shaft and widened out transversely forming a domed chamber. The north end of this was found to have a free passage into No. 12, but that on the S. had only a low creep-hole leading into No. 6. The end of this gallery opened out into two passages which also led into 12, so that the communication between our pit and shaft 5 was freer than elsewhere. The filling in of this area is instructive. Gallery 12 when first entered had on the W. side an apparently continuous wall. This is now seen to be made up of passages and buttresses. The whole of No. 7 gallery was filled in except a small portion adjoining No. 6, and this had been done from gallery 12. No. 4, another outlet from the latter, was filled from that side as were also the creep-holes of gallery 19. There was thus no outlet for the men after they had blocked up gallery 7, except shaft 5. From this and other facts it is clear:

(1) That several shafts were open at the same time.

(2) That a free communication existed below ground between the shafts.

(3) That shaft 5 was being worked a little later than pit 1.

(4) These facts support the conclusion that the infilling of the shafts is contemporary with the working of the mines, and the implements, etc., found in the shafts are of the same date.

The same conclusion is drawn from gallery 13. Access to our shaft was cut off when galleries 4 and 14 were blocked, either from our side or that of shaft 3, and this shaft was also open a little later than pit 1.

These facts suggest that the mining was being extended to the N. and E. rather than to the W. as seemed likely from the direction in which most of the layers were thrown into our pit.

The small galleries are three in number, viz, 1, 6, and 9. They differ in size and shape. No. 1 is a small edition of No. 7, but has a marked difference. It was never used as a passage to convey flint and chalk from the deeper part of the mine. The communications at the end of its side apses are really only air holes, whilst that at the end, which leads to No. 4, barely allows space through which to crawl. Nos. 6 and 9, which appear from the plan to be one gallery with a buttress between, are really quite separate, the ventilation hole between them being quite small.

The plan shows that the object was to find flint and not to make galleries. The flint seam was followed as far as possible, leaving walls and buttresses of variable size and shape. The galleries vary in breadth from 4-5 ft., except where apses are cut, when they are considerably wider. In certain parts, adjoining galleries are so freely connected that they are perhaps best described as large irregular chambers with columns left to hold up the roof. Where this occurs, no doubt, the seam of flint proved richest. A considerable amount of flint still lies in the mine, especially in the apses, seen in the plan of the galleries. This was never worked below the floor.

No wood was found, and no bones which could be used as shovels; nor did the roofs or walls show any black marks from the use of lamps, and they were also free from stains. The method of filling the galleries is quite clear; blocks were first piled at the sides and the finer chalk brought in baskets and thrown in the centre.

To some extent this was done to support the roof, though occasionally a slight interval was left between for ventilation, in which case there was no support for the roof. It is curious that the Lingheath miners adopt the same system. They call it to "jamb" the roof. In the "Guide to Brandon," Mr. W. G. Clarke has given an account of a flint mine at Lingheath, and in a visit I made to one of these it was possible to trace several parallels. The older shafts, of which there must be thousands, bear a resemblance to those of the Graves, except that they are much smaller. The sand through which they are sunk has filtered down to form cups in the older, whereas the most recent ones are crescentic, owing to a space being required over which the miner has to carry the flint and the chalk taken out in digging the shaft and earliest galleries. Round the entrance of the Lingheath pit were a dozen flint heaps called "jags," built up in a regular manner, of which some little piles in the galleries at the Graves formed

miniature copies. The shafts themselves are not circular like those at the Graves, the first cut being a parallelogram marked out by the primitive custom of placing chalk in a figure of that form. This cut is generally 3½ ft. by 6 ft., but in the one we visited it was 3 ft. by 11 ft. The shaft is sunk in stages of 5½ ft.—6 ft. in depth. The first measured 6 ft. and the next step 3½ ft. by 3 ft. The next drop was 5½ ft., and the step 4 ft. by 2 ft., so that the measurements are roughly estimated.

In the sides various layers of flint were passed. Hornstone, second hornstone, upper crust and wallstone—5½ ft. below the previous layer. Then came another layer of hornstone, 1½ ft. below the latter (seen in pit 2 at Grime's Graves), and the floorstone was 8 ft. below the wallstone, about a foot deeper than at Grime's Graves. The base of the pit was square, and from it four galleries were worked. These were 2½ ft. in height and 4½ ft. wide, and did not follow a straight line. Here, too, the workman follows the seam of flint and does not trouble about the symmetry of the gallery. Some of these galleries were 54 ft. in length. The work is done with an iron-headed pick, apparently modelled on a deer-horn, by sitting on the floor and delivering the blows from the side. The method of extracting the flint is seen at once to differ, as the chalk is worked out for 1 ft. below the seam, and the nodule—for the flint is not in a continuous band—is levered out with a crowbar and broken up with an iron-headed hammer. To sit in one of these galleries is to imagine oneself in the old workings at Grime's Graves.

The old galleries at Lingheath, too, are filled in with chalk; those in which the roof seems weak to the top, whilst in others a space is left for ventilation. In his method of working the seam the new miner has deviated from the custom of the older, and, by sinking a smaller shaft, has adopted a most ingenious system of steps with the addition of a small toe hole in one side of the wall, by the aid of which it is quite easy to ascend and descend the shaft—a method which the Grime's miner could not adopt with a shaft of such large dimensions.

REMAINS OF RED DEER FOUND IN PIT 1. (HORNS).

Layers 1 and 2 yielded very little evidence of red deer: a fragment of a horn and one tine from the former, and parts of a horn from the latter. In layer 3, between 6 ft. and 12 ft., were found a first year's horn, a fine crown of three tines from the end of an antler, a broken horn, and two good antlers above the hearth. The remains from the black band were fragmentary, and some of the horns were burnt. In layer 5 three separate tines, a brow core and a fine slain deer antler, were found with all the tines complete. The foreman's pick just grazed the last, and by carefully removing the chalk blocks it was got out complete. In the sand, too, from the edge of the pit were a separate tine, a first year's horn, and

some broken portions of horn between 11 ft. and 15 ft. At 17 ft. S., in the sand of layer 6, was the end of an antler with two tines.

It was not until we reached 21 ft. S. that we began to find undoubted deer-horn picks, so that these were all lying in the lowest four layers, viz., Nos. 7, 8, 9 and 10, below the boulder clay and sand, which as a compact layer extended to 17 ft. S.

In layer 7 three of the four picks were near the fireplaces (2 and 3), the former at 24 ft. S., and the latter at 27 ft. S. As has been previously mentioned, these probably marked the spots where picks were made. Those referred to above were not, however, recently made, but bore signs of use, as the ends of the brow tines were blunted and similar to those from the galleries, which had been cast aside as useless.

In layer 5, at the east end of the pit, picks came to light at a higher level, viz., 21 ft. S. Between this and 25 ft. S. five good picks were found, together with two pieces that were probably broken horns. Below this level six others occurred, one of them on the floor of the shaft. At 24 ft. and 25 ft. S., in the sand of layer 4, two tine ends (one of them cut) and two picks were found. The lowest layer of all, made up of chalk blocks covering part of the floor, contained ten picks in addition to those actually in the mouths of the galleries, which were blocked up by parts of layers 8, 9 and 10. In addition, in layer 10, were two fine ends of antlers, one with three tines and another with four, at 27 ft. S., the latter on a level with fireplace 3, whilst below it was a separate tine. A group of three picks lay close to or just inside the mouth of gallery 1, together with a first year's horn and two long tines.

First year's horns were not numerous—six altogether. One was in the west tilt (No. 3 layer) at 6 ft. S., another was in the sand of the edge at 15 ft. S., one was buried in rubble inside gallery 1, and another lay in the entrance. Of the other two, one was close to the floor, 29 ft. S., in the entrance to gallery 2, and the other in the centre of the pit, 26 ft. S. They were all shed, and some bore signs of use. They were consequently not from animals used as food, and were probably used as hand levers to prize out the blocks of chalk after they had been loosened with the large picks.

A group of 4 picks also lay near or inside the mouth of gallery 6 with two just buried in the sandy rubble which filled this opening. From the number of picks grouped about the common entrance of galleries 8, 10, 11, and 16 it is clear there was plenty of flint available in this direction. Of these galleries only No. 11 was completely cleared out, and it is probable that many more picks lie buried in this area. Four lay either in this entrance or just outside it. About 17 were buried in the rubble which filled the common entrance just beyond the shaft walls, some of them singly and others in groups. One group of 3 came from gallery 11 and two groups of 4 and 3 respectively from gallery 10. Another fine collection of 4 was buried in the talus at the extreme end of gallery 8. Another prolific part of the mine had an exit to

Surroundings of Pit 1, with antler-picks found up to April 2nd. (Photo by A. L. Armstrong.)

the shaft through the entrance to gallery 2. This was also completely cleared out and yielded 17 picks, of which 12 lay in groups of 5, 4, and 3, in addition to which were two others in the mouth. Opening into this gallery were two great passages, 3 and 18, which combined for about 6 ft. In this common entrance, completely blocked to the roof, which we only investigated for a short distance and that only at the top, were found a further 11 picks thrown aside singly, in pairs (2), or in a group of 3. Just beyond the end of gallery 2 another group of 3 was found, and in the small gallery 14 another 8. So that in this small area grouped about gallery 2 we obtained 41 picks, and the area of galleries 3 and 18 probably contained still more. The long gallery 13 yielded us 12–14 picks, one group of 4 of fine proportions. Of these three came from the talus of shaft 3, one of which was broken, and as the gallery was not cleared at all, there were probably others near the floor. Gallery 5, which was partly filled with the talus from another pit (shaft 1), and would be an outlet for the miners, where they would naturally cast aside their worn-out tools and replace them, also yielded to Mr. Armstrong, who worked here, 10 picks, including a group of three. The talus probably contained others. Another main gallery, No. 7, which, in spite of its size and importance, had an entrance through which it was only possible to pass by lying flat on the bottom of the shaft, yielded about 11 picks after about three parts of it had been cleared out. Most of these, however, were in such a fragile condition they fell to pieces when touched. The horns in galleries 11 and 12 were in the same state, probably due to the dampness of the chalk at these spots. But in any case it points to great antiquity. No. 1, which was completely cleared, yielded only one pick in addition to those grouped about the mouth, and the two picks and 4-tined crown of an antler grouped on the open floor. Gallery 6 had a group of three buried in the rubble in addition to those at the mouth, and of three others which lay singly the finest was a hammer pick of a slain animal found by Mr. W. G. Clarke. (Plate XXIII.) Gallery 9 contained groups of 3 and 2 respectively, and another found lying on the top of the rubble just inside the entrance. Neither of these last two galleries was completely cleared.

In all 28 picks came from the shaft between 23 ft. S. and the floor (30 ft. S.) to which may be added 9 more which lay just inside the mouths of the galleries buried in material thrown into the shaft making 37, in addition to which there were two at 22 ft. S. and one at 21 ft., 40 in all. At 27 ft. S. occurred the greatest number, viz., 11, with 9 at 25 ft. S. 23 lay between 27 ft. and 30 ft. S., and 23 between 25 ft. and 27 ft. S. inclusive, whilst 35 or all but 5 lay in the lowest 6 ft. of the pit, and the rest were only 3 ft. above this level. They were all in the lowest 9 ft. of the pit. In Canon Greenwell's pit the picks were all found below 17 ft. from the surface, *i.e.*, in the lowest 23 ft. of the pit. In this pit 18 ft. of pure chalk filled the lower part, and in that case some of the picks were in a space of 5 ft. above this level which contained sand.

THE FAUNA OF PIT I.

(BONES IDENTIFIED BY C. W. ANDREWS, D.Sc., F.R.S.)

LAYER 1.—Horse: Scapula, long bones, teeth separate and in jaw, 2-3 ft. D. Ox: Long bones, vertebræ, lower jaw, teeth, 2½–3 ft. D. Roe deer: Tooth 2½ ft. D.; tooth 3½ ft. D. Red deer: Long bones, cervical vertebra, astragalus, 2½ ft., lower end of femur 4 ft. 19 bones.

LAYER 2.—Red deer: rib. Sheep: long bone. Roe deer: 3 teeth in jaw.

LAYER 3.—Red deer: long bones and boiled pieces. Small ox: long bone. 3A: sheep; red deer; ox. 3: boiled bones, sheep, etc. 3B: roe, 10½ ft. 14 bones; rest not identified.

LAYER 4.—*Black band.*—Red deer: humerus, 13 ft., burnt bones. Roe deer (?). Sheep. Ox: long bone, 13 ft., vertebra and rib, 9 ft. Long-tailed field mouse: teeth, lower jaw, right maxilla, left ramus, upper incisor. Field vole: teeth and mandibular ramus. Bank vole: lower incisor, jaws without teeth, teeth and mandibular ramus, right ramus. Bechstein's bat; tip of bird's beak; bird's claw; bird bones; metatarsus and coracoid of passerine bird *cf.* thrush; humerus of passerine bird *cf.* starling; common toad. 6 large bones.

LAYER 5.—Roe deer: long bones, part of lower jaw with teeth, 14 ft. Pig (?): cervical vertebra. Ox: below human skull. Red deer: rib. 6 large bones.

LAYER 6.—No bones. In sandy edge continuous with layer 6, Ox or deer: condyle of jaw, 6½ ft. Roe deer: long bone, 10 ft.

LAYER 7.—No bones.

LAYER 8.—Mole: radius and scapula, 22 ft. S. Rabbit, very young ulna, 25 ft. S.

COVE OF WALLSTONE (opposite layer 8).—Natterer's bat: lower jaw. Bechstein's bat: skull and lower jaws.

LAYER 9.—No bones.

LAYER 10.—Red deer: rib, 29 ft. S. Whiskered bat: skull and bones, 27 ft. Daubenton's bat: lower jaw. Bechstein's bat: skull, 26–29 ft. Mole: skull and jaws and bones. Natterer's bat: skull and bones. Whiskered bat: skull and lower jaw, 29–30 ft. (entrance to galleries 8 and 10).

GALLERY 1.—Bechstein's bat, 2 specimens.

GALLERY 2.—Bat: bones.

GALLERY 5.—Bechstein's bat: skull.

GALLERY 8.—Natterer's bat: 2 skulls and bones. Mole: skull and skeleton, inside the gallery 6 ft. from the shaft.

GALLERY 10.—Field vole: jaw and bones.

GALLERY 11.—Red deer: part of skull. Lower end of tibia artificially hollowed, scratched and cut (talus of shaft 2). Long bone. Field vole: part of skeleton.

GALLERY 12.—Vole: skull and bones. Bat: skeleton.

GALLERY 13.—Vole: skull and bones.

As will be seen from the list, the fauna of this pit is a scanty one. The domesticated animals include horse, ox, sheep, and doubtfully pig. The wild animals, red deer, roe deer, rabbit (very doubtful), and some small mammals, birds, and reptiles, viz., mole, two specimens, one of which reached the bottom of the pit alive, as it was found 6 ft. from the entrance in gallery 8: four varieties of bat, 3 varieties of rodent, thrush (?), starling (?), and common toad.

The horse remains consisted of a large part of the skeleton with part of the skull and jaws with teeth *in situ*. They were at the base of the top layer of rain wash. At Cissbury the bones of horse were superficial.

Ox occurs in 4 layers, viz., 1, 3, 4, and 5. The lowest level for this animal was 16 ft. S., where a bone was found 2 inches below the human skull wedged in between the blocks and consequently contemporary with the layer. Sheep remains were very scanty in layers 2 and 4, reaching the 15 ft. S. level. Pig was only represented by a vertebra not sufficiently preserved to make identification certain. Dog is not recorded.

Of the wild animals red deer came from layers 1, 2, 3, 4, 5, and 10, and from the galleries; roe deer from layers 2, 4, and 5. The evidence for rabbit is very slender as the bone was very light and was probably blown in from the surface during the excavations, especially as strong westerly gales prevailed at the time.

It will be seen that no bones of domesticated animals were found below 16 ft. S.; the majority being in layer 3 and 4 at 14 ft. S. and 15 ft. S. respectively. The bones from layer 3 had been boiled, and consisted mostly of red deer and sheep.

The Excavation of Pit 2.

The second shaft selected by the Committee was more in the centre of the whole area and nearer to the S.W. corner, as shown on the plan. The selection was influenced by the fact that this pit was already 7 ft. deep measured from the highest point of the surrounding mound, which lay to the east. If the floorstone were on the same level as in Pit 1, the bottom of the shaft should be only 23 ft. below the surface of the cup. This estimate proved very nearly correct, the shaft itself, cut through the chalk, being 17-18 ft., compared with 20 ft. in Pit 1. There was here, however, a larger mass of material above the chalk, so that the total measurement slightly exceeded Pit 1, viz., 31 ft., compared with 30 ft. in the latter.

As will be realised from the fact that there are 346 definite pits in the whole area, the selection was not an easy one. The pits at the extreme N.E. near Section 9, or the extreme S.W., might prove to be the earliest or latest of the series; on the other hand, a large one such as that selected might well contain more objects of interest. It was not originally intended to try and reach the bottom of this shaft as the time at our disposal was short. It seemed a pity, however, not to complete the work and examine the galleries, and this was accomplished by augmenting the staff.

Pit 2 was practically circular, and measured 42 ft. E. to W., and 43 ft. N. to S. It was surrounded by a broad mound of more uniform height than Pit 1, and belonged to the group of large isolated shafts. Beside it, to the N.E., was perhaps the largest pit in the whole area, which was used by us to receive the material thrown out of the shaft. To facilitate this, a gangway was cut through the intervening mound, a section of which is given later. (Section 10).

The work was commenced on April 4th, a standard level set up, and the four cardinal points fixed. At each of these points a trench was cut to find the chalk lip in order to see how much of the surrounding bank would have to be cut away. In doing this the surface of the chalk was found to vary, being 4½ ft. below the surface of the cup on the S. side, and 7 ft. on the N., W., and E. On the S. side the material cut through showed a series of small washes or lips which did not run towards the centre of the pit, and suggested that on this side a gangway had been cut to a pit on the S. to facilitate the removal of material whilst one of these shafts was dug. The section here showed chalk rubble 9 inches, red sand 3 inches, boulder clay 9 inches, and sand 1 ft. 9 inches; below which and resting on the chalk was a little boulder clay, which extended over the edge. As in Pit 1 we decided to cut a section E. to W., and as the S. was more accessible than the N. lip, the face of the section lay in that direction. So that, while both of the diagrams show the layers across the centre of the pits they represent different faces. Having ascertained the position of the S. lip, we proceeded to cut a trench to the centre of the pit and then clear out

the S.E. section for a depth of 3 ft. At the same time the surface of the S.W. section was removed. A stage was erected over the N. side of the pit on which the material was thrown and the gangway cut, as previously mentioned, into the adjoining pit. As in Pit 1 we found in the top layer of rainwash numbers of chipped pieces. On April 7th a hearth (1) was exposed in the S.E. section 3 ft. from the S. edge and 10½ ft. from the E. edge. It was on a level with the chalk lip. The face of the section to the E. showed that at this spot very little boulder clay lay above the chalk, but a considerable amount of sand, both of these running over the chalk lip. On the following day we began to realise the great size of the pit selected, and decided to try and reach the bottom by taking out one-half only. The possibility of this depended on the nature of the material which filled the shaft. Loose blocks without any matrix, or fine dry rubble, would defeat the object. On prolonging the cutting to the centre of the pit we cut into another mass of charcoal (fireplace 2). This was actually at a higher level than the one first found. Having completed this section we commenced to clear that on the S.W., and on April 9th the human remains (described separately) came to light. The following day the rest of the skeleton was found, and the occipital bone at 17½ ft. S. On April 7th we cut into another batch of charcoal which ran under the level we were working, made up of blocks (2b) in the S.E. section. This proved to be the commencement of a band marking two occupation levels and corresponding with layer 4 in Pit 1. The beautiful series of implements found in that layer is referred to in the description of the layers. On April 10th we cut into the sand of layer 4 and began to find deer-horn picks. In the meantime realising that the N. sections would not hold as we got lower, extra men were employed to lower the surface at that side, and the stage in consequence was moved back to the edge of the pit. During the Bank Holiday interval work was suspended and a closer investigation of the galleries of Pit 1 was made, and Floor 3 was also examined. When work was resumed on April 14th, some of the face of the section had fallen, and it was impossible to go much deeper with the S. part until the N. side was lowered. Work was therefore concentrated on this half. It proved to contain a large tilt of sand which yielded very little of interest. A heavy fall in the N.W. part was fortunately stopped by the roots of a large tree which held the edge together, otherwise, the sand being deep in this direction, the work would have been much delayed. Lowering the S. half of the pit, we exposed below the black band a continuous line of sand which ran across the pit from east to west. On April 15th one could observe the remarkable resemblance in the layers of the two pits as can be seen by comparing the sections. A mass of wallflint came from the base of the sand in the centre. At this point, 19–20 ft. below the top of the mound, five definite layers could be seen, between which were three bands of charcoal in the positions indicated in the section. In addition, at the extreme ends, the tops of two other layers were discerned. A detailed drawing of this was

made that evening by Mr. E. T. Lingwood, and this was a fortunate matter, as during the night a large part of the centre of the section fell down, compelling us to take out a broad piece from the N. side on a level with the black band, to prevent a repetition when the S. part was again lowered. On April 18th the shaft was spanned with poles (Plate XIV., top) and the tripod and windlass set up, the materia lbeing afterwards removed by bucket.

The existence of a band of sand forming a cup across the face of the section seemed to corroborate the suggestion in Pit 1 that ice might have passed over the area of the Graves after the pits were partly filled in, thus referring the mines to a very remote period. In this case, however, the layer was not formed of boulder clay, but of sand. The matter, so far as this pit was concerned, was set at rest on April 20th, when another fall of the face took place, after we had lowered the S. section. This disclosed the fact that layer 4 did not form a complete cup across the pit. There had been a large tilt of sand from the south, which reached the centre of the pit, and was there joined by sand which had come in from the west and east, forming across the centre the layer seen in the section. This tilt from the S. had not been big enough to run quite across the pit, and that coming in from the N.E. had not met it, as on the east and west sides; consequently there was an interval where the charcoal of the black band (layer 3) lay immediately on the large blocks of layer 5. The sand in this case then was tilted in, and was not brought in by ice and afterwards decalcified. The same day we reached the wallstone at 24 ft. S., which was exposed in the E. and S., where a cove or recess had been cut out in working it. A layer of pipe-clay, 1 in. in thickness, was seen running in the shaft 3½ ft. above this, and at 22 ft S. a small band of sand ran into the pit from the side between the chalk blocks. In the south-west section, in the sand just above layer 5, and partly between the blocks, a mass of tiny bones came to light, where apparently a colony of bats had taken refuge, and it is not improbable the sand was thrown in and destroyed them. Two little recesses or coves, where the wallstone had been worked, were uncovered in the S.E. and S.W. sections. Above that on the S.E. Mr. D. Casey noticed some grooves on the chalk face, probably caused by ropes used in hauling up the flint. All the other similar marks were on the soffit of the heads of the galleries. On April 21st the head of a gallery, subsequently called No. 4 (Plate XVI., bottom), was exposed in the S.W., and when the men left off work several were in view. The same evening Lieut. W. Hall, Mr. Casey and I set to work and cleared away the chalk from one of these, and at 6.30 that day we were able to enter galleries 1 and 2, described in that section. On the following day entrance was gained to galleries 11 and 3, and later in the day to gallery 4.

It was made more evident as the N. section was cleared that the blocks of chalk which lay between the two occupation levels in the black band were tilted in from the N. Another fireplace (No. 4) was found in that section at 20 ft. S. between the blocks of layers 3 and 5, resting on the sand which had filtered in from

Pit 2. "Sundial."
(Photo by "Prehistoric Society of East Anglia.")

that direction, and quite distinct from the black band level. On April 24th Mr. Casey, who had been investigating gallery 11, called my attention to some marks on the end of the buttress which formed the dividing line between galleries 2 and 3, evidently caused by a smooth axe.

Most of the lower part of this pit was filled with large blocks of chalk (layer 5), but we had been able to define two other layers to the west, viz., layer 6 made up of fine chalk rubble with blocks below resting on layer 5, and a small sandy layer, No. 7, which lay below it, and on April 25th came to a small fan-shaped sandy tilt, No. 8, which as in Pit 1 ran from the level of the wallstone over the head of the buttress and gallery below. After the men finished work on Saturday, April 25th, Mr. Casey opened out the entrance to gallery 5, and was able to penetrate to the end. On April 27th the rubble and sand covering up the entrance to gallery 6 were removed, and in doing this some vertical lines could be faintly traced over the head of the gallery.

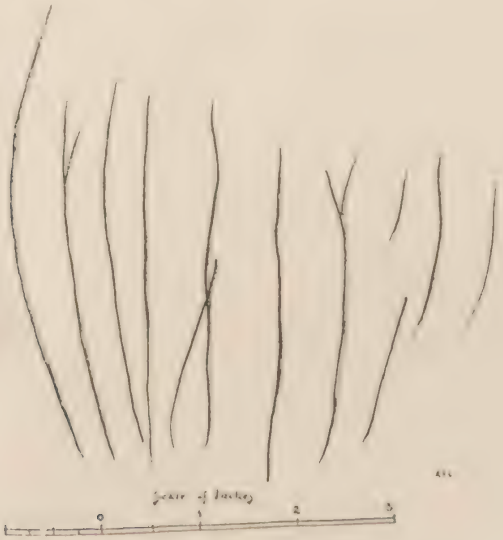


Fig. 5. "Sundial."
(Drawn by E. T. Lingwood).

These "Sundial" marks were 7½ ft. above the floor of the shaft, over the S. side of the spring of the arch at the entrance to gallery 6, immediately above the upper level of wallstone. Close under them was the platform mentioned, and it should be noticed they could not have been cut when standing on the floor of the shaft. These lines, as Plate XII. and Fig. 5 show, were 12 in number. Ten of these are nearly parallel converging at the base to a common centre. There are three curved ones on one side and six on the other. The largest is 9½ inches. Two are forked above,

and the centre line is crossed diagonally. It was noticed that the sun at 12 o'clock noon shone on this face, and this and the form of the lines suggested a sundial.

These were filled with sand, and became clearer as it dried, and was blown off the face by the wind. The sand covering the N.W. face of the shaft had also preserved the chalk face, and as the former was blown away it was seen that the chalk was rubbed, evidently by the miners in passing in and out the shaft. A little later, entrance was gained to gallery 6 which proved to be a good-sized chamber in which it was a great relief to be able to stand upright. Two entrances only remained to be explored, but as they were packed solidly to the roof we had to wait until the men had cleared them out.

Layer 5 had proved to be fairly rich in pottery, which unfortunately was of the consistence of clay and very difficult to remove. The levels at which this was found are given under "Layers." A number of deer-horn picks had come to light in the lower part of the shaft, but not in such quantities as in Pit 1. As the lines above gallery 6 became more distinct, it was evident they were artificial, and the other walls were examined more closely. That above gallery 4 was also coated with sand, and as this fell off another interesting series was seen.

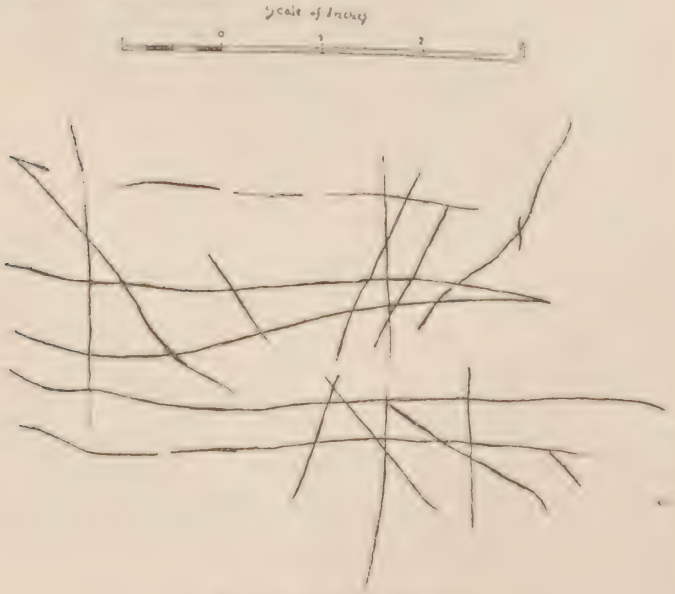
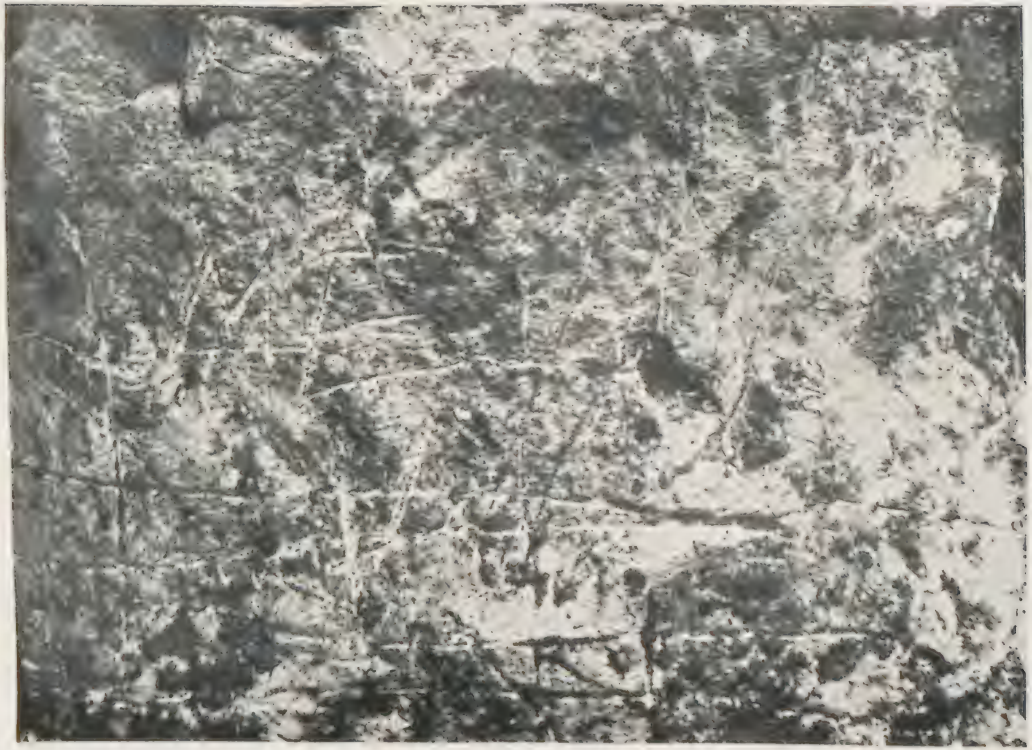


Fig. 6. "Tally Marks."
(Drawn by E. T. Lingwood).

The "Tally Marks" were cut on the buttress between galleries 4 and 7. They are seen from Fig. 6 and Plate XIII. to consist of four parallel lines with a curved one running diagonally



Pit 2. "Tally-marks." (Photo by "Prehistoric Society of East Anglia.")

between. At the ends are two long vertical ones crossing the others. Beyond on the right is also a short vertical one. There are in addition a series of three diagonal lines from the right, and two from the left. These are not continuous with three others which cross the other diagonal ones and the two lower horizontal ones. These two sets of marks were examined by a number of people and pronounced to be artificial. They could have been scratched with a flint flake.

Unfortunately this latter spot was selected by a visitor on which to record his initials, a strange mania which, to a certain section of the British public, appears to be irresistible. Photographs were taken of these sets of marks (Plates XII. and XIII.), both of which must be ancient from the circumstances under which they were found. The initials on the latter bring out clearly the difference between the recent and ancient marks. Mr. E. T. Lingwood also made accurate drawings of these (Figs. 5 and 6). Similarities with those found by Mr. Park Harrison at Cissbury are noted (p. 29). It was unfortunately impossible to remove these records without destroying them, as the chalk was much fissured at this point.

In clearing the floor of the shaft beneath the rubbed face of chalk we encountered a very tough mass of beaten sand and rubble so firmly cemented together it was with difficulty removed with the pickaxe. On removing the blocks round it a platform with ill-defined limits was seen to be placed to the west of gallery 6, and it seems not unlikely that this had gradually accumulated at the spot where the flint was habitually hoisted to the surface.

The floor of the shaft was entirely cleared on April 30th, and its true dimensions were then seen. A good deal of the lower part of the face had fallen, one buttress between the entrances of galleries 3 and 5 collapsing whilst our work was in progress. The remainder of our time was occupied in clearing out the colonnade. (gallery 10), and on May 1st we were able to enter galleries 7 and 9, and subsequently 8.

In clearing gallery 10 some pottery was found inside the arch resting on a ledge of floor flint, and a step was found raised from the floor of the shaft to that of the gallery. The clearing of this colonnade gave us an inkling of what a wonderful sight the removal of the chalk rubble would disclose, and it is a great pity that more time could not be devoted to clearing out the galleries, especially as there may be evidence in the form of implements, etc., which would help to date the whole industry, buried beneath the chalk.

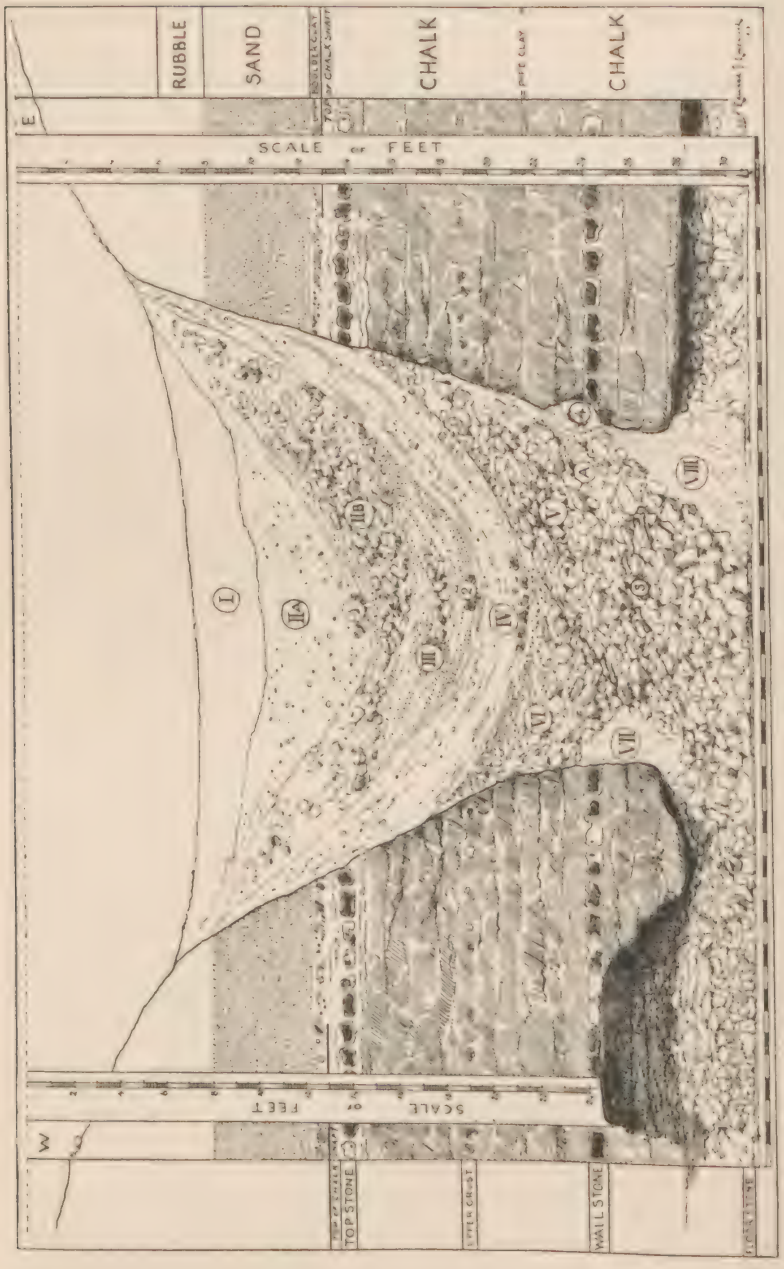


Fig. 7. Section of Pit 2. Drawn by E. T. Lingwood.

DETAILED DESCRIPTION OF THE LAYERS.

LAYER 1.

This consisted of sandy rubble, no doubt due to rainwash. It measured 3 ft. in the centre, thinning out at the sides. It was deepest on the N. side, as No. 2 layer came in from the S. and had a slanting top. The chipped pieces were mostly at the base of the layer as in Pit 1, and were deeply patinated white on each side. In the wash were quantities of shells—*Pomatias*, *Vitrea*, *Pupa*, *Lapicida*, and *H. nemoralis* being the most obvious. About 50 well shaped implements came from this layer, one of which, a massive steep-ended scraper, resembled specimens from Peppard and Ringland. Three good drift forms (Fig. 30), too, were found—one of them being picked out by the President, Mr. J. Reid Moir, who was watching the work. There was also a number of large choppers and part of a hammer in the S. section. At 2 ft. was found a pointed implement with a reverse hinge fracture, and in the S.W. section a fine ball hammer patinated white.

LAYER 2.

This was found ultimately to consist of two distinct tips: 2A, a fine dry rubble which seemed to have been subjected to the action of frost, and came in from the S.W., stretching across the pit to the N.; and 2B, a mass of large tabular chalk blocks tilted in from the E. Between these two was seen fireplace 2. When first uncovered the blocks 2B were thought to be part of the fine rubble above, and being in apposition were included in that layer. The pieces in the layer below having in the meantime been labelled, this was called 2B.

2A: This contained a considerable number of shells, of which there were literally hundreds, as did the second layer in Pit 1. Three feet from the S. edge fireplace 1 was found, 5 ft. below the cut edge. It rested partly on the sand which had fallen from the lip or been tilted in. This mass of charcoal measured 2 ft. in length, 1¼ ft. in breadth, its long diameter being N.E.E. by S.W.W. It dipped a little towards the centre of the pit, and at that end was part of a charred beam, which broke in pieces. There were no large hearth flints, but a number of burnt pieces lay round—chiefly flakes—and no definite pot-boilers such as were found in section 7. Near it were some flint cores and large flakes. Another fireplace (2), entirely distinct from the former, was cut into later. This is the band seen in the section. It was confined to the centre of the pit, 4 ft. below the cut edge and 1 ft. higher than the last. It sloped towards the centre and is seen lower than this level in the section. A number of burnt flints were scattered here, possibly the remains of a hearth, and round it and in the charcoal were found burnt bones—red deer teeth, part of the lower jaw of an ox, and some long bones. Close beside these were five large flint hammers or mullers, and beneath, in the chalk, a quantity of partly chipped nodules of flint and large coarse flakes patinated a deep navy blue. No small

flakes, however, were found at this spot; indeed, small flakes were confined to the sandy edges in both pits. This patch of charcoal was 1½ ft. broad and 6 in. deep, and the shells were so numerous here, especially *H. nemoralis*, as to suggest they had been used for food—a doubtful point, as they were mostly whole. In the rubble were some large scrapers, a pointed ovate implement of drift form, a rough pick, a racloir reminiscent of the Moustier industry, and a steep faced plane of dolphin form (Fig. 31). Altogether about 30 shapely pieces came from here.

2B: This layer of chalk blocks had little of interest in it except the bones enumerated in the list, which were very fragile, and a quantity of large coarse flakes. There was a good deal of floor flint.

THE BLACK BAND.

Layer 3.

This marked a definite occupation level of two distinct periods. Between these a tilt of blocks took place partly from the N. and partly from the E. This layer commenced on the S. 2 ft. below the fireplace No. 1, 6 ft. from the S. lip, where it was 1½ ft. across and 2 ft. below it, *i.e.*, 15 ft. S. It spread across the centre of the pit, where it showed itself in the section to be 10 ft. broad. It extended only a small distance to the N., just beyond the limit of the sand (layer 4), and at that part lay on layer 5. Beyond this layer 3 had been tilted on the latter. From it a number of interesting things came to light. It was not possible, however, to distinguish between the two layers of charcoal, as the chalk was dry and fell down in the form of a talus as we advanced. There is evidence from here that the people chipped implements, cooked their food, and probably prepared their deer-horn picks on this spot, though no actual specimen of the latter was found intact. Amongst the bones found here, some of which were burnt, were the jaw and long bones of a dog, which Dr. Andrews estimated to be about the size of an Airedale terrier. The dog found in the Peppard pit was found by Mr. A. H. Cocks, F.Z.S., to be rather smaller than a pure-bred Lapland dog, but of different proportions and with a smaller head. It was about the size of a large Irish terrier, and therefore somewhat smaller than the dog found at Grime's Graves. There were also fox, calf, sheep, ox, and roe deer bones from this layer, and a slain red deer-horn, with part of the jaw and teeth, and some separate tines, which latter suggested the making of picks.

Remains of their flint industry consisted of large cores and big flakes, and a split hammer slightly blue. At the sandy edge were a quantity of finer flakes. There was also a number of burnt flints smaller than any hitherto found, but not so distinctly pot-boilers as those in section 7. Many good implements were scattered through the charcoal and rubble, including a finely made flake scraper (Fig. 35), three good discs (Fig. 34), a parallel-sided celt (Fig. 33), a steep-faced plane, a knife made out of a broad flake trimmed round the edge, and a form of dos abattu. One of the

Pit 2—(Top) The Shaft and its surroundings. The tripod is over the middle of the Shaft.

(Middle) View of Shaft from surface. Entrances to Galleries 3 and 5 beneath ladder, Gallery 2 on left, Gallery 1 in centre, Gallery 4 on right, and colonnade Gallery 10 on extreme right.

(Bottom) Entrance on left leads to colonnade Gallery 10, and beyond into Gallery 7. The buttress between the two openings has fallen away. A step is seen between the floor of the Shaft and the floor of Gallery 10. (Photos by A. L. Armstrong.)

Pit 2—(Top) Group of 5 antler-picks buried in chalk rubble at entrance to Gallery 6. Photographed *in situ* when still partly buried.
(Middle) Entrance to Gallery 4.
(Bottom) Picks lying on talus of chalk blocks, Gallery 8. (Photos by Dr. A. E. Peake.)

discs was found by the foreman, and was the finest yielded by the excavations. It was almost circular, with a diameter of about 4 in., very thin, and chipped all over both surfaces, with much delicate work on the edges. There were also two blocks which appeared to be ochre. From these remains we obtain an insight into the life of the people, scanty though it is. Some of the girl's bones were at the edge of this layer.

THE HUMAN REMAINS.

On April 9th whilst the S.W. section was being worked, the first of a series of human bones came to light. We were close to the S. limit of the chalk rubble (layer 2) which being shot in from this side lay partly on the sand which formed a thick covering for the chalk face at this point. Just at the extreme limit of the black band (layer 3) where rubble, sand, and charcoal were mixed together, a human tibia (Plate XVI., top) was found, and close to these were a femur, ulna and radius, a fibula, and another tibia. This was 8 ft. below the cut edge, and 4 ft. below the chalk lip, which was higher at this point in relation to the standard level and cut edge than in the E. and W. sides = 15 ft. S. The bones were close together, either above or below, or on a level with the commencement of the black band, but as this was a very thin layer and the whole mass fell into our trench it was impossible to say definitely how they were placed. We next found a humerus a little lower and more to the S.W., 4½ ft. below the chalk; at this point somewhat lower = 16½ ft. S. This was in the sand, which was here 5 ft. in thickness, covering the shaft wall. We next uncovered the lower jaw 13 ft. from the W., 6 ft. from the S., and 6½ ft. from the nearest point of the S.W. edge. It was almost perfect except for the articular process and some of the incisor teeth, the latter being found when the sand was sifted over. The extreme shallowness of the jaw was a noticeable feature. This was 6 ft. below the chalk, 17 ft. S. Close by were some of the ribs, the clavicles, a humerus, and some of the incisor teeth. A little lower down were more ribs and a digit. At 20 ft. S. an astragalus, pieces of vertebra, part of the scapula, and ribs, and what looked like a portion of the base of the skull but in a very fragmentary condition. The exact position of all these was measured and recorded in the journal. The back of the skull consisting of the occipital bone was not found until the following day, April 10th, at 17½ ft. S. It was brought to light by Lieut. W. Hall, who was then helping in the work. The rubble and sand had been cleared away to the 17 ft. S. level at this spot, and we were working along a face of large blocks (layer 5) three feet below. The bone which was very thin and fragile (a great contrast to the skull from Pit 1) lay embedded in the chalk, immediately below the surface on which we had been standing, and it is somewhat remarkable it was not broken entirely to pieces. It was taken out in the presence of Mr. E. T. Lingwood, Lieut. W. Hall, Mr. D. Casey, and Dr. B. P. Allinson. It lay 5½ ft. from the S. point,

8½ ft. from the E., 14 ft. from the W. lip, and one foot below the black band, which at this point was 1 ft. thick. The skull lay further in the pit and was separated from the lower jaw, being also a little lower. With the exception of the occipital bone in layer 5 and a tibia partly in the black band, all the bones were in the sand.

The question arises, was this skeleton thrown into the pit before or after it was occupied as a dwelling-place? It seems unlikely that it is from a grave disturbed in making a new pit, as in that case the bones would be more completely mixed. More probably the grave was immediately on the margin of the excavated pit, the bones gradually falling down the side or being brought down by the feet of the miners as they went to their dwelling place. The skull which lay furthest away from the edge would be more likely to roll to that distance, and the fact of the lower jaw being found a little distance away points to the soft parts being already decayed. The alternative is that the girl's body was thrown in entire, and the position of the bones to some extent supports this view, as the arm and leg bones were mostly above, and the vertebrae and ribs below, the position in which they would lie if the body rested on the back. The sand, however, lay at a steep angle upon which a body would not rest, whereas individual bones might be buried in it.

In any case, the remains are older than the black band occupation, and it is somewhat singular that the skull found in the first pit was also in the same relation to the black band.

Layer 4.

As in Pit 1 the boulder clay ran over the chalk lip and coated the sides of the shaft all round. By following the thickness and direction of the sand in different parts of the pit, it was clearly tipped in from various directions. The largest of these tips came in from the S.W., as has been mentioned, and forms the layer seen in the section. Another was tilted in from the E. and extended to the S.E., lying at an angle of 20°, and being 5 ft. in thickness. Two-and-a-half ft. of sand covered the sides of the shaft for most of its extent. Another mass came from the N.E. and ran to the S.E. At 21 ft. S. this was 9-10 ft. across. The base of this sand in the centre of the pit had a mass of wallstone nodules unworked. In parts the sand was very tough, notably in the S.E. and S.W. sections, where it covered the blocks of layer 5. This was possibly due to exposure, unless it represents a mass of boulder clay thrown in at this spot. About ten good chipped pieces came from the sand at the side. The flakes all round the edge were similar in appearance to those found in the same position in Pit 1. One hammer-stone was found at 4 ft. D. Most of the pieces from this layer were embedded in its surface. The most noticeable were a massive tea-cosy with wavy edge, a triangular massive piece which seemed designed for use as an axe, and a fine blue-black flat celt (Fig. 36), of which Dr. Allinson found a similar one on floor 3c. This was at 21 ft. S. in the

Above: Human bones and lower jaw found in the filling-in of Pit 2, showing the remarkable length of tibia compared with femur. (Photo by Dr. A. E. Peake).

Below: Entrance to Gallery 4, Pit 2. (Photo by A. V. Campbell.)

bottom of the layer. One fine flake had a hinge fracture at the end and a facetted bulb, patinated white and mottled with blue. There was also a thin disc and two thick planes of the Tarté type. The few bones that came from this layer, and the human ones, were far better preserved than those in the adjoining rubble. The first perfect pick came from the base of this layer, and the ox tooth found on April 9th was buried in the surface of it.

LAYER 5.

Large chalk blocks from the lower part of a pit, which came in from the N.E. and spread right across the shaft, filled up most of the lower part. Its upper limit was 14 ft. S., and the blocks lay at an angle of 30°. It thus formed a large cylindrical mass with a diagonal face, measuring 17 ft. at its highest point. The blocks were not weathered and some of them weighed 9–10 lbs. With the exception of two lots, all the pottery found in this pit came from between the blocks of this layer. It was all very soft and resembled clay in consistence. To a certain extent this was due to the dampness of the chalk and the white fungus, but partly no doubt to imperfect firing of the clay. The flints in this layer and the bat bones were also covered with fungus. Two pieces of pottery came from 22½ ft. S., another from 24 ft. S., 6 ft. from the edge in the S.E. section. Two more pieces lay just over the entrance to gallery 8 at 25½ ft. S., and a lower part of a pot was 2 ft. from the N.E. edge at 21 ft. S. A little lower down, between the chalk blocks, was a large piece of the consistence of clay, including a piece of rim with a simple ornament. Other pieces were at 27 ft. S. in the N. and W. sections, and two more in the entrance to gallery 6 (Fig. 80). The implements were of unusual interest. One foot below the occipital bone was a flat implement of the adze type, 18 ft. S., and near it a disc of drift form. At 22 ft. S. a batch of good pieces came to light: a large rough celt, a steep undercut cone engrailed (a second was found close by), and a flake worked along the edge near the end, all these being patinated. One massive piece chipped on both faces had a coarse wavy edge round the margin, and resembled a tortoise core (Fig. 37). This occurred at 27-ft. S. Another of these came to light in the same layer. On the top of this layer in the N. section was fireplace 4, close to the sand coating the shaft wall at 27 ft. S. It contained charcoal and burnt flints. Another spot on which a fire had been kindled was 2 ft. above the floor of the shaft, at 29 ft. S. at a distance of 2 ft. from the west buttress of gallery 6. It was only a pocket of charcoal and perhaps marked the spot where a pick had been made. Another was on the floor of the shaft. It consisted of charcoal, burnt sand, and flints, with parts of burnt deer-horns. It lay 3 ft. from galleries 4 and 5 opposite the intervening buttress. A coated nodule found close to the floor had been used as a hammer, and at the entrance to gallery 5 was a long chipped block of flint unpatinated. The platform close to gallery 6 has been referred to. It ran about 8 ft. into the shaft and was 2½–3 ft. in height, and was

made up of alternate layers of sand and fine chalk. A similar raised spot lay in front of gallery 5. It was not, however, so high and is best described as a tough mound of sand and chalk rubble trampled down into a hard mass. It was just above this that the rope marks were found above the wallstone recess. There were some 37 good chipped pieces from this layer. The deer-horn picks are described under that section. No bones except bat were found in this layer. A small layer of sand ran across between the blocks from the edge at 22 ft. S. in the S.E. part for about 3 ft. into the pit.

LAYER 6.

At the W. end of the pit beneath the sand a small tilt of rubble and blocks had come in. It started at 19 ft. S., and the blocks lay at an angle with those of the layer below. No shells or bones were found, but a few fragments of charcoal lay between the blocks.

LAYER 7.

A fan-shaped layer of sand tilted in from the W. lying directly below the blocks of layer 6. It commenced at 24 ft. S., and was about 1 ft. in thickness and covered the face of the shaft at this spot.

LAYER 8.

Another similar fan-shaped mass of sand commencing 6 ft. from the S. point from the same level as the last, and covering the head of the buttress of No. 5 gallery, and no doubt helping to form the battered mound described above.

THE EMPTY PIT AND HOW IT WAS FILLED.

On looking into Pit 2 when emptied, it is seen to be more rugged than Pit 1., and on this account appears not to be circular. The lower part especially is irregular, but this is largely due to the condition of the chalk, which owing to fractures has fallen away and left large buttresses projecting. The heads of the galleries, too, are not flush with the shaft walls, but fall away owing to the same cause.

The pit in this case is 42 ft. E. to W. and 43 ft. N. to S. It is funnel-shaped, so that at 24 ft. it is 19 ft. by 20 ft. and at the base 14 ft. by 14½ ft.

In the shaft wall the top of the chalk is prominent, and above it in the cut portion are seen a very thin layer of boulder clay, a considerable thickness of sand, with a small portion of chalk rubble above, the uncut side of the mound being presumably made up of the same material. The chalk is capped with large flints, the top-stone. Six feet below the chalk lip is seen the upper crust seam of

Pit 2, from the bottom.
(From a drawing by E. T. Lingwood.)

flint, represented by a few scattered nodules. Two-and-a-half ft. below this a thin layer of pipe clay can be discerned, and the wall-stone layer, some 11 ft. below the chalk, is marked by three little recesses or coves. The chalk below this layer is seen to be cut away, though it may have fallen in places. The rubbed face of the shaft is distinctly traceable for a width of 3 ft. on the N.W. side, from a distance of about 6 ft. (19 ft. S.) above the tops of the galleries. In places, too, the floor-stone is just visible on a level with the bottom of the shaft. The sundial can be quite distinctly seen, especially when the sun shines on it, and the position of the tally marks over gallery 4 can be easily located by the recent initials which stand out clearly from the old surface. The base of the shaft is seen to have eight main openings, which are the entrances to the galleries, and there are in addition two small air holes. Those which still retain the original head on which the cord marks were found, viz., 4 and 6, are seen to be flush with the shaft wall. Two sets of galleries are seen to have a common porch, viz., 3 and 5, and 6 and 8 (more correctly the latter run into gallery 10). The buttress of the former, however, fell during our work, and no doubt the others were also originally separated.

As in Pit 1, it is interesting to reconstruct, from a study of the layers, the order in which the pit was filled in. As at Lingheath the mine was not worked in all directions at one time, and at the end, just before the mining ceased, nearly all the galleries would be blocked up. Of these only 1, 4, and 2 had the entrances open. In this case also the floor of the shaft was certainly not clear at the end, but was occupied by two distinct masses. One of these was the sand and chalk platform which had gradually accumulated beneath the rubbed face of the shaft owing to frequent small falls of sand dislodged when the flint was raised, and to some extent of chalk falling off the blocks themselves. Another mass of less definite form lay in front of galleries 3 and 4, and from the rope marks above also formed a spot from which flint was hauled to the surface. The fan-shaped mass of sand (layer 8), which appeared to have contributed to some extent to the mound mentioned above, may have fallen before the mining ceased. It is evident, however, from the three spots on which fires had been lit—probably for the making of deer-horn picks—that the floor was not kept clear of chalk. We have seen that in one of the French mines, viz., Mur-de-Barrez, the work of splitting up the flint nodules was assisted by fires which had been kindled in the galleries. We have at Grime's Graves no evidence of this, as very little flint was fired at the bottom of the shaft, and the waste pieces from the galleries likewise showed no sign of alteration.

As soon as the pit was altogether abandoned, the lower part was filled in by large blocks (layer 5). These filled the entrances of the still-open galleries, and were tilted in from the N.E., probably from the immense pit which lay in that direction. Very soon after this, before the weather had had time to split up the blocks, two little masses were thrown in from the west side; the lower (layer 7)

might be a fall of sand. It came down the face of the shaft and we owe the preservation of the tally marks to this factor. The chalk above it was the other "tip" at this time, and it helped to fill up the lower part of the pit, leaving a V-shaped ditch running on the top of the fill-in at that point. Some of this had been broken up by exposure, and as the correspon ling surface of layer 5 on the E. was still in an unchanged condition, made up of the blocks as they were tilted in, we must conclude that the sand (layer 4) which lay over it was thrown in very soon after. The small tilt of chalk from the W. shows that, as in Pit 1, several shafts were open at one time. I have already described how the sand came to form a layer across this pit, and have also suggested that the human bones fell on to the top of this layer. The pit was used as a dwelling-place, when it was 19½ ft. deep, at two distinct periods, between which chalk blocks were thrown on the lower band of charcoal from the N. The later dwelling surface was then covered by a tilt of blocks, some 2 3 ft. in thickness (2B), which came in from the E., and was again used for habitation after this had taken place. An even larger mass of soft chalk was then thrown in from the S.W. (2A) and lay exposed to the weather, becoming split up by frost. With this came a great accumulation of shells, which points to a considerable amount of vegetation on the surface at the time. The pit was also used as a dwelling-place before the whole of 2A was tilted in, as the fire-place in the south part testifies.

As in Pit 1, rain and wind brought in sand and fine chalk from the surrounding mound, and this filled up the pit to within 7 ft. off the top.

THE GALLERIES.

In this section I shall give an account of the appearance of the galleries and the way in which they had been filled in, and at the end shall try and show from the latter in which direction the mine was being worked.

GALLERIES 1 AND 2.

On looking over the talus the entrance was seen to be partly open with three horns (two of them picks) partly buried in the chalk which lay beyond. It was seen to branch at the end, though mostly blocked, and two picks lay partly buried in this direction. In this the first gallery entered, it was noticed that the undisturbed chalk was soft and in a fissured condition, and this fact suggested it would not be safe to work away the chalk in the blocked galleries to the same extent as in Pit 1 where it was firm and hard. The whole of this part had been filled in from one shaft, leaving the creep-hole open into gallery 2. This gallery proved to be small but well proportioned. The entrance to the shaft was low, 2 ft. in height, and a good deal of the rubble floor was visible along the east wall where a line of floor flint was seen. Waste flint lay amongst the blocks

GRIME'S GRAVES EXCAVATIONS

1914

PLAN OF GALLERIES FROM PIT No. 2

NOTES.

Deer Horn Picks indicated thus ⊨
Polished Axe Marks on walls ↑
Bones discovered as follows :-
GALLERY I – Bat skull.
GALLERY III – Two bat skulls.
GALLERY V – Natterer's Bat skull & Bank Vole jaws & bones.
GALLERY VI – Natterer's Bat skull, jaw, & teeth.
Pottery indicated thus *
Implements indicated thus ×

SHAFT OF PIT
Floor 31'0" below surface level

Tally marks, or primitive sun-dial, on shaft wall 7'6" above floor.

Rope, or thong, grooves on lintol of entrance.

Tally marks, or primitive numerals, 7'6" above floor.

Rope, or thong, grooves on lintol. Two pieces of carved chalk found in entrance.

Platforms of alternate layers of chalk rubble & sand.

Fireplace No. 5 on floor.

Step up.

Fragment of pottery *

Flint in situ

Partially filled with inflow of sand and gravel from shaft.

Air or light hole.

Passages blocked up solid.

Tales from shaft.

Tales.

Low creep.

Flint in situ.

Hole to light.

Partially filled with loose rubble.

Flint in situ. Partially filled with loose rubble.

Flint in situ.

Low creep.

Air or light hole.

Polished axe marks.

Very low.

Filled with loose rubble.

Sloop faced × black scraper.

Flint in situ, mined blocks & chippings.

Floor exposed.

Moderately open. Large fallen slabs. Roof insecure.

Large blocks of chalk piled on this side up to roof level.

Blocked.

Blocked solid.

Passages blocked up solid.

Unexplored Gallery filled solid to roof.

Unexplored Gallery filled up with rubble to roof.

Probable gallery here. Blocked up or filled solid.

Unexplored Gallery filled solid to roof.

Tales of flint.

Roof of A inclines lower at B.

Floor exposed.

Very low.

Flint in situ.

Partially filled with rubble & chalk blocks.

Partially filled with rubble & chalk blocks over packed.

Flint in situ & filled blocks.

Loose rubble filling to within 3' of roof.

Blocked air hole.

Flint in situ, blocks & chippings.

Floor exposed.

Unexplored Gallery Blocked up solid.

Unexplored Filled up with rubble.

Solid filling.

Blocked passages with sleep slabs to floor.

Height 7'6" wallstone flint exposed and partly worked in roof.

Connects to Bat block.

Unexplored Probably connects to Gallery XIII.

Packed solid to roof.

Unexplored Probably connects to Gallery XII.

Wrecked & disturbed.

Air hole to blocked gallery.

Chalk lump.

Floor exposed.

Blocked solid.

Low creep.

Partly open.

Mined flint blocks & chippings.

Creep hole to unexplored gallery blocked solid.

Blocked entrance to gallery.

{60 Deer Horn Pick marks counted in this apse.
Eleven glancing blows, apparently of a polished axe, where indicated ↑

Termination uncertain. Apparently an apse but may connect to an adjoining pit.

M. MAGNETIC NORTH. TRUE NORTH.

SCALE OF FEET.

A. LESLIE ARMSTRONG, F.S.I. SURVEYOR. SHEFFIELD. 1914.

FIG. 8.

but none was piled up at the entrance. A fine pick lay, however, in this spot. Deer-horn pick marks were seen, many blows of which were delivered from the side, but no marks made by polished axes. The gallery was 10 ft. 9 in. broad, and 12 ft. long. It had not been used to pile up chalk from other areas. Through the creep-hole marked on the plan, which was 18 in. broad and 10 in. high, access was gained to gallery 11. Flint could have been passed through this, but it could hardly have served as an entrance.

GALLERY 11.

This proved to be fairly lofty, probably 6 ft. when emptied, due to falls from the roof. The right side was entirely blocked. As will be seen it ran at right angles to 3 and 5. The S. end was also filled, and the chalk at this point was in a cracked and fissured condition. The roof may have fallen at this point in some quantity but not extensively as there was no cavity above. It looked unsafe and no attempt was made to investigate in this direction. The rest was fairly open and led into the end of gallery 3. The marks noticed on the buttress already referred to were originally covered by chalk blocks, and when carefully examined were found to consist of a number of smooth axe marks, eleven of which were counted together. Most of them were glancing blows, but some gave the end impression of the implement used, of biconvex section. The long diameter showed the blows were delivered both from above and below. The wall at this point, however, was domed, and it is difficult to see how such a blow could be struck if the implement had a handle. It is possible the axe was held in the hand and used as a wedge or lever, the butt being hammered with the head of a deer-horn pick. Below these marks, when the blocks were removed, was found an apse with floor flint, the chalk above it having deer-horn marks, some of them made by broken-ended picks. A steep-faced chipped piece fresh and black came from this spot.

GALLERY 3.

Through the door way left unblocked in the last gallery it was easy to pass to a partly open apse which formed the end of this gallery. The miners had not at this spot left a disused pick as we generally found to be the case. The marks, however, were unusually numerous, some of them striated from the pick end having become broken. I counted 60 of these marks in this small area. A few of the blows were delivered from above, but most of them from the side, and as the Lingheath miner works in the same way this is evidently the easiest method of working in a confined space. The rest of the gallery was considerably blocked, though it was possible just to squeeze to the entrance.

GALLERY 4. (Plate XV., middle, and Plate XVI., bottom.)

This was very interesting when we first entered it on April 22nd through a doorway 2½ ft. broad blocked up with chalk

but none was piled up at the entrance. A fine pick lay, however, in this spot. Deer-horn pick marks were seen, many blows of which were delivered from the side, but no marks made by polished axes. The gallery was 10 ft. 9 in. broad, and 12 ft. long. It had not been used to pile up chalk from other areas. Through the creep-hole marked on the plan, which was 18 in. broad and 10 in. high, access was gained to gallery 11. Flint could have been passed through this, but it could hardly have served as an entrance.

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GALLERY 4. (Plate XV., middle, and Plate XVI., bottom.)

This was very interesting when we first entered it on April 22nd through a doorway $2\frac{1}{2}$ ft. broad blocked up with chalk

from the shaft. At that time the north section of the pit still had a large mass of chalk in it which rose up at the side of the entrance in a threatening manner. The gallery was found to be fairly open, but blocked to the N., with a fine high roof. Three good picks lay on the talus beyond, and on the right was a very small apse where the flint had been worked. We were able to penetrate to the end with some difficulty and found a low creep-hole which led into another blocked gallery. At the end was a fine pick mark, but no axe marks. In the entrance I found a chalk ball and a long chalk cylinder, both evidently carved. The entrance arch of this gallery was intact and the rope marks seen on the soffit have been described.

GALLERY 5.

Mr. D. Casey entered this on April 25th and reached the end, though it was blocked up near the shaft except for a narrow passage. Beyond the creephole it opened out and an apse was found to the N., which communicated with a lofty gallery, 17, unfortunately blocked up from the other side to the roof. Another creephole was similarly open to 16, and this gallery, too, was blocked. The entrance to 13 was not found until later, as it was entirely hidden by chalk blocks. At the end of this gallery there were some good marks of a polished axe. Two were in the apse, others on the wall nearer the shaft, and others on the roof. Deer-horns had also been freely used. Mr. Armstrong found here a chalk block, 7 inches long, which seemed to be artificially hollowed for use as a lamp. This gallery and 13 were filled from our shaft. At the entrance of this gallery the foreman found an axe of grey flint, with battered edges of the same type as that (Fig. 28) found in Pit I., but of superior workmanship.

GALLERY 6.

The door of this was only $2\frac{1}{2}$ ft. high and $2\frac{1}{2}$ ft. wide, narrowing to $1\frac{1}{2}$ ft. It proved to be the loftiest of all the galleries, and was 6 ft. before the floor was cleared. This was due to the roof having fallen, exposing the hornstone nodules which formed quite an ornamented barrel-shaped span, $5\frac{1}{2}$ ft. across and 12 ft. in length. The end was entirely blocked, and two fine picks lay partly buried in the rubble. A flat implement was picked out of the chalk on the floors with crust on one face and the edge much battered.

GALLERY 7.

It was not possible to enter this gallery until May 1st, when the colonnade 10 was cleared. It had been left fairly open, and about half of the chalk originally in the area removed elsewhere, that remaining being from the further end. A photograph of this gallery was taken. (Plate XVIII.) It gives a good idea of the end of a gallery just as the miners left it with their discarded picks and waste pieces of flint. The wall was much stained with manganese.

End of Gallery 7, Pit 2, showing three antler-picks as they were left by the miners at the face of the "floorstone."
(Flashlight photo by "Prehistoric Society of East Anglia.")

View of the colonnade Gallery 10, Pit 2, with entrance to Gallery 7 on left.
(Photo by "Prehistoric Society of East Anglia.")

The apse in this case was a cul-de-sac. No trace of a polished axe could be found, but deer-horn pick-marks were abundant. The larger blocks of chalk were piled on one side. The adjoining gallery 9 was accessible through the creephole. It was largely blocked up, but beyond the mass of chalk was found an apse with floor flint exposed.

GALLERY 8.

This was entered when the colonnade was cleared and very much resembled No. 7. The main passage into it was blocked as will be seen in the plan, and from the width at this point it was evidently a main passage to another shaft to which this gallery belonged. In the plate the talus blocking up the entrance is seen on the left. The four picks shown in the plan were found there, no doubt worn out in working the flint. A minute examination failed to find any polished axe marks.

GENERAL CONCLUSIONS, GALLERIES, PIT 2.

There is a good deal of difference between the two sets of galleries of Pits 1 and 2 when the plans are compared. It will be seen from the map of the Graves (Fig. 1) that the shafts round Pit 2 are further away than those round Pit 1, and this will to some extent explain our failure to penetrate to the base of any adjoining shaft. In Pit 1 this was only accomplished after some days of work, as the communicating passages were entirely blocked. The chalk in Pit 2 consisted largely of fine pieces far more difficult to remove than large blocks. The fractured condition of the walls and roof in this pit suggested that the miners found it dangerous to drive long tunnels, as falls of the roof would be more liable to occur, and it is all the more surprising to find that the shafts are further apart. The flint seam may not have been so rich, however. So far as one could judge from the plan it was possible to make of this series, Pit 2 did not communicate so freely as Pit 1 with its neighbours as in only one case, gallery 8, were we able to find a passage leading directly away from our system.

We found, however, indications that the chalk was just as extensively hollowed out in this part as in Pit 1 in the blocked galleries 16 and 17, at the end of 5, and 15, at the end of gallery 4. In each of these cases, however, the openings were too small to allow the chalk to be freely carried for disposal into the worked-out galleries of our system as was done in Pit 1. A comparison between the two plans show that the galleries were not cut on any common model beyond that of piercing the chalk in all directions round the base of the shaft. The portion cleared out in Pit 2, viz., the colonnade (gallery 10) showed that in this pit also the galleries blended into a large chamber with buttresses to support the roof, as in galleries 11 and 8, and 7 and 12 in Pit 1. The same thing seems indicated in the plan in the S. area of this mine. In this case,

however, the walls between galleries 3, 2, 11, and 1 are only pierced by low openings and not by high passages as on the opposite side.

The whole of the N.W. area of the mine is seen to consist of four long parallel galleries each ending in a rounded apse, three of which are blind and have not been worked out to meet the gallery of an adjoining shaft. There were no main passages beyond those indicated, but some of the small openings, which time did not permit us to uncover, may be hidden. The colonnade (gallery 10) (Plate XIX.) running parallel with the shaft wall forms an interesting distinction between the two pits. It formed a crescent-shaped passage with a roof nearly 6 ft. high, and the floor was on a higher level than the bottom of the shaft, a step being cut between them. Considering the fractured state of the chalk it is remarkable that the miners were able to cut so large a span of roof as is shown where 10 and 4 unite. Galleries 1, 3, 11, and 13 are evidently main passages leading into the deeper parts of the mine, whilst 2 and 6 are small chambers, the main entrance of which was from the open shaft. The other outlets shown in these last two galleries are not main passages but low creep or air-holes, through the former of which it was only possible to pass with difficulty.

In how many galleries was the floor flint exposed at the time the mine was abandoned? We can exclude galleries 8, 9, and 7, as, though at the ends the flint was still exposed, they had been blocked up entirely from the direction of our shaft when the colonnade 10 was filled in, partly through the entrance where the step was cut (the one to the east was quite low and only a creep-hole), but mainly through the entrance to No. 4 where the chalk mass terminated in a steep talus. Nos. 6 and 1 were similarly filled except for a space near the shaft, and showed no open flint seam. A small apse was still in a working condition on the N. side of gallery 1, but the rest of the gallery was nearly blocked. Nos. 3 and 5 had open apses with floorstone exposed, but these were a long way from the entrance and the intervening passage barely allowed room through which one could crawl, and it is doubtful if any work had been done at these spots for some time before the mine was closed. Only two spots were really accessible to the shaft at the end, viz., in galleries 4 and 2.

This has an important bearing on the number of miners who were employed at one time. Only one man could work in the small apse of No. 4 gallery, and not more than two or three in No. 2, with others, perhaps, carrying the chalk to disused galleries or hauling the flint to the surface. The rubbed surface of the shaft pointed to a short amount of exposure to weather conditions, if rain and frost prevailed, and in order to work out this extensive area of galleries a large number of men would have to be employed. This is directly opposed to the conclusions arrived at by a study of the galleries. It is possible, however, that the work was carried on in a warm and dry period, which would preserve the face of the shaft from destruction for a much longer period.

Two picks uncovered in apse at entrance to Gallery 10, Pit 2.
(Photo by "Prehistoric Society of East Anglia.")

Group of antler-picks found during the excavations.
(Photo by Dr. A. E. Peake.)

THE RED DEER HORNS.

Pit 2 did not yield nearly as many horns as Pit 1, but this was undoubtedly due to the small portion of the galleries cleared. The shaft, too, was not so rich.

In the larger shaft, Pit 2, there were only 18 complete picks and 8 broken, compared with 29 complete ones in Pit 1 and 3 broken.

In Pit 2 the picks were found at a higher level, viz., at 19 ft. S. A broken one was found in layer 3, and two complete and several broken ones in the sand of layer 4 at this depth. Above these, within 4 ft. of the surface of the cup at 11 ft. S., there were some parts of a horn and two antlers at 17 ft. S. Separate tines were uncommon in the shaft, only five in all being found, two of them showing old fractures. No first year's horns were found in this pit.

Four picks came from layer 4, 14 good and 4 broken ones from layer 5, and a broken one from layer 6. The first of four perfect picks was found 6 ft. below the chalk lip, with several broken ones, and others came to light all through the lower part. Of the total, 9 were 3 ft. from the floor, including a group of 4 not far from the entrance to gallery 4. All the picks were contained in a depth of 12 ft.

To the numbers cited above must be added 23 good and 2 broken ones grouped just inside the entrances to the galleries, making 41 good and 8-10 broken, a total of 49-51 in all. As only the two entrances to the colonnade gallery 10 and part of 6 were actually cleared out, the number of picks buried just inside is proportionately larger than in Pit 1, one can assume that a fair number still lay buried. Gallery 3 was evidently the exit for a fairly prolific area of the mine, as 7 picks lay within the entrance, 3 to the right and 2 to the left; whilst 2 others were 3 ft. inside the gallery.

An equally-rich seam was evidently met with in the E. part of the mine, as seven picks lay discarded at the mouth of gallery 5, and two more were found at the end. The picks actually exposed in the N.E. group of galleries were not very numerous. In gallery 4 three lay in the rubble and one was buried at the mouth in the apse. In gallery 7 three fine picks were found. In gallery 8 four were grouped at the end. (Plate XV., bottom.) When the entrance to gallery 10 was cleared 9 picks came to light, including a fine group of 4, and some 5 or 6 were found buried in the gallery itself. (Plate XX.) For its size gallery 6 was also prolific. Two were exposed on the talus when we entered, and three others were buried in the rubble close to the roof. One of the finest groups found during the work was buried close to the floor just inside the entrance of this gallery. A photograph of these picks was taken (Plate XV., top), when they were partly exposed to view. They consisted of a group of five, four of which had been placed side by side with the heads upwards against a mass of chalk, and another one along the top. Above them was a mass of chalk, some of which may have fallen

from the roof. At the entrance to gallery 1 were two picks and a crown of three tines, which lay partly buried in the talus facing the doorway. They were not, however, in a straight line as in gallery 1, pit 1.

There were thus 29 complete and 5–6 broken picks from the galleries, and some 26 in the archways, making 60–61 in all from this area.

FAUNA OF PIT 2.

IDENTIFIED BY C. W. ANDREWS, D.Sc., F.R.S.

LAYER 1.—Ox: long bones, tooth (incisor), os calcis, part of femur, 3 ft. Sheep: teeth in jaw, 2½ ft. D., (?) long bone. Roe deer: long bone, 2½ ft. Red deer: ribs, end of femur, teeth, 2½ ft. D. 9 bones and also teeth.

LAYER 2.—Ox: teeth in jaw, burnt jaw, shaft of long bone. Young ox; fireplace (2) 7 ft. D. Red deer: teeth. Sheep or small deer: teeth. Small sheep. Lamb: long bone. Pig: tooth, 3 ft. D. Grass snake.

LAYER 3.—Ox: bones and burnt teeth in jaw. Calf: teeth, long bones. Sheep: metacarpal, teeth. Small sheep: distal end of tibia and os calcis. Red deer. Dog, size of Airedale terrier: ulna and other bones. Fox: jaw and teeth, metapodal, part of scapula, and distal end of humerus. Roe (?), young: part of femur. Passerine bird; wood mouse; field vole; bank vole.

LAYER 4.—Ox: tooth (top of layer). No bones except bat.

LAYER 5.—Quantity of bones, skull and jaw. Bechstein's bat, 19 ft. S. Field vole: teeth and bones.

LAYER 6.—Bechstein's bat: bones and skull. Bank vole.

GALLERY 1.—Bat skull.

GALLERY 3.—Two bats' skulls.

GALLERY 5.—Natterer's bat: skull and lower jaws. Bank vole: jaws and bones.

GALLERY 6.—Natterer's bat: skull with teeth and lower jaw.

The list from this pit is scanty, but varies a little from that of Pit 1.

The domesticated animals include ox, sheep, pig, and dog. Ox in layers 1, 2, and 3. One tooth is recorded from the top of layer 4, but as layer 3 was an occupation level it probably belongs above. Calf in layers 2 and 3. Sheep in layers 1, 2 (lamb), and 3 (small sheep). Pig, one tooth in layer 2, 3 ft. D. Dog, layer 3 (size of Airedale terrier).

The wild animals include red deer, roe deer, fox, and some of the small wild animals of the period, viz., long-tailed field mouse, two kinds of vole, and two kinds of bat. Red deer in layers 1, 2, and 3; roe deer in 1, 2, and 3; fox in layer 3 (black band). The voles extended to the lower layers, one bank vole being found in a

gallery. As two of the deer-horns in gallery 8 were gnawed, one of the voles evidently got into the shaft alive. It could not have fallen in without injury, and this points to the use of poles or a ladder in the shaft. Grass snake is also recorded from layer 2, and a passerine bird from the black band.

It will be noticed that no bones of domesticated animals or even roe or red deer came from below the sandy layer. All the animal bones belong to the area above the bottom of the black band, *i.e.*, 12 ft. below the grass, 19½ ft. S.

Pig is only represented by one tooth. It was doubtfully included in Pit 1. No remains of horse came from this pit.

MINING METHODS.

How long it took the miners to sink a shaft it would be impossible to tell, unless an experiment were carried out with implements similar to those used at that time. These were apparently deer-horn picks, of which they could obtain a plentiful supply, and flint axes, with perhaps deer-horn and flint hammers and wedges, when the tabular chalk was reached. These implements would not, however, be sufficient to remove the chalk after it was dislodged, and it is probable that some wooden tool was used. General Pitt-Rivers experimented with the scapulæ of ox and pig, and found them clumsy to use. A flat piece of wood might however have been split off a suitable branch and roughly trimmed into a spade, possibly shaped like the one of Roman date found at Silchester and preserved in the Museum at Reading. The chalk had, too, to be brought to the surface, and whilst the larger blocks could easily be carried, the finer rubble would require some form of vessel. It is possible that the fragments of fibre found in Pit 2 and at Peppard are the remains of baskets of osier used for the purpose. Something of this sort would certainly be required to remove the sand, for the loosening of which a flint adze would be more serviceable than a deer-horn pick. It is quite clear the miners could not climb the sides of a shaft of this depth without some contrivance. The joist holes suggest that woodwork was used and the rope marks over the heads of the galleries would indicate that the baskets were hauled to the surface with thongs or ropes.

We are quite in the dark as to the number of men employed at one time in a shaft. The state in which the galleries were left suggests they were few. The rubbed face of Pit 2 and the tally marks still preserved on the chalk face, on the other hand seem to point to a large number of men being employed to exhaust the flint seam in a short space of time, otherwise the rubbed surface could scarce have resisted the combined effects of frost and rain. It is, however, possible that the climate at that time was mild and dry.

Some sort of guide as to how long it took the miners to sink a shaft can be derived from the record of the length of time taken in

clearing out our first pit. The removal of the contents of a pit is, of course, a far quicker process than sinking one through the solid chalk; and a better estimate would be formed by noting the time taken in sinking a well. In a shaft of this size a good many men could be employed at one time, and with plenty of available labour a large shaft should be dug quicker than a small one.

Pit 1 had a surface diameter (at the top of the mound), after it had been enlarged, of 32 ft. by 32 ft., and a total depth of 30 ft., 4 ft. of which was already empty. Allowing for 3–4 ft. of rubble (an outside estimate) piled on the original surface, we find that 26 cubic feet of material were removed. The pit diminished from 32 by 32 ft. to 12 by 11 ft. from 4 ft. S. to the 18 ft. S. level, below which for 12 ft. it remained at the latter diameter.

In order to estimate the capacity of the pit, and the amount of material used, Mr. J. E. Sainty, B.Sc., of Norwich, has worked out the following figures:—The total capacity from the top of the mound to the bottom of the pit was 7500 cubic feet (the figures are in round numbers, and for convenience a circular pit is assumed). When the work commenced, however, the mound rose for 4 ft. above the centre, and consequently 2500 cubic feet of material must be deducted, leaving 5000 cubic feet removed during the work. The upper 12 ft. taken out by digging and staging to 16 ft. S. contained 3400 cubic feet, and the remainder from 16 ft. S.—30 ft. S., removed by means of the bucket, 1600 cubic feet.

We commenced on March 2nd with three men, two employed in digging and one in wheeling away the material. As the floor became deeper a stage was used on to which the material from below was thrown, so that, after the first few feet, the whole of the material was dug out by the foreman alone. By this method 12 ft. to 16 ft. S. were cleared, leaving only a stage of chalk. This work took 14 actual working days, and was concluded on March 18th, after which a day was lost in rigging up the tripod and bucket. The latter method was slower, but the floor was reached on March 25th, and completely cleared on March 28th. Excluding the day lost, mentioned above, and half-a-day owing to a severe snowstorm, the pit was completely cleared in 20 working days of 9½ hours each, excluding meal times. The work, too, was carried on in the wettest March on record. It was spread over 25 days and rain fell, more or less—generally more—during 12, adding considerably to the weight of material lifted.

The method employed in extracting the raw material is very well seen in both pits. As soon as the floorstone at the bottom of the shaft was reached it was removed from the whole area as far as the shaft wall, and the seam was followed by driving fairly uniform galleries in all directions. It is clear that these galleries were not all driven at the same time by a large staff of men, as in that case the entrances and intervening buttresses would be at regular distances. The main galleries were worked in a straight line, fairly uniform in height and width, and from the sides semi-circular hollows were cut out in extracting the flint nodules, and

formed the apses seen in the plan of the galleries. The flint, occurring as it does in nodules and not in a continuous tabular band, would no doubt be extracted in large lumps as far as possible by picking away the chalk above, and at the sides, with the red deer antlers. The apses bore ample evidence of this method of work, but wedges do not seem to have been used, as there were no marks pointing to these.

The marks of a smooth axe were so few in number (in most of the galleries there were none at all) that it was evidently but seldom used. A chipped axe was also occasionally used. When a nodule was too large to be extracted in one piece, or too heavy to move, it was split up by means of deer-horn picks, the heads of a large proportion of which were considerably battered in this way. Some still had spicules of flint embedded in the horn, whilst the battered chalk floor was filled with the broken fragments, especially in the apses where the fractured face of the flint was exposed.

The galleries gave us some idea of the amount of labour expended in working a mine of this description. Those grouped round Pit 1, which include two or three belonging to adjoining shafts, were found to measure roughly 412 ft. Taking an average width of 4 ft. (an under-estimate) and a height of 3 ft., and excluding from the calculation the apses, we find that 4964 cubic ft. of chalk and flint were removed from this area, and either brought to the surface or piled up in the abandoned galleries.

COMPARISONS BETWEEN THE THREE SHAFTS EXCAVATED.

PIT 1—PIT 2, 1914. CANON GREENWELL'S, 1870.

The two shafts excavated in 1914, and that in 1870 are, as shown in Fig. 1, situated in different parts of the Graves' area. It is supposed that the work in the whole mining area was spread over a very long period. If this is the case, some distinctions would almost certainly be found, and it becomes instructive to make a comparison between the three shafts and their contents. To some extent this can be done by studying the preceding pages. In order to facilitate this further I have put the facts in a concrete form.

The three shafts do not embrace the whole area of the Graves, and it is still possible that the pits in the extreme N.E. differ in some particulars from those in the extreme S.W. corner. The smaller size of the pits in the latter, of which about 100 are grouped together, suggest that they may be of later date, but this is a point which can only be decided by further excavation. It seems probable that the seam of flint worked from each pit—or, rather from each group of pits, as we have noted that several were open

at one time, would take a long time to exhaust. The three parts examined are widely separated, and should show some slight differences if the duration of the mining extended over a very long period.

To economise space I shall use the numerals (1) for Pit 1; (2) for Pit 2; (3) for Canon Greenwell's pit.

The diameter and depth of each shaft:—

(1) Circular (the oval form due to the material thrown in from the west), 29 by 32 ft. at mouth, funnel-shaped for the upper 18 ft., vertical for the lower 12 ft., diameter at base 10 by 11 ft., 30 ft. deep.

(2) Circular, 42 by 43 ft. at mouth, funnel-shaped above, vertical lower 10–11 ft., diameter at base 14 by 14½ ft., 31 ft. deep.

(3) Circular, 28 ft. at mouth, tapering to bottom, 12 ft. in diameter, depth 39–40 ft.

The three shafts are all large and differ in this respect from Spiennes and the modern pits.

Natural strata and material above the chalk:—

(1) 10 ft. of material above the chalk made up of chalk rubble 3½ ft., sand 1–3½ ft., and boulder clay 3½–4 ft.

(2) 13–14 ft. of material above the chalk, the surface of which is not horizontal, made up of chalk rubble, sand, and boulder clay, as given in Section 10.

The boulder clay, though variable, is more than 6 ft. in thickness, and the sand 2½ ft., with rubble above. (The section at the cut edge of Pit 2 does not show the true thickness of each.)

(3) 13 ft. of sand above the chalk, according to Canon Greenwell's statement. (*See* Sections 14 and 15.) Sand appears to measure 6½ ft. at this spot, and no boulder clay is present, the total depth of material above the chalk being 10-11 ft. According to these sections this pit is not so deep as the measurement originally given.

A comparison between the natural sections seen in the three shafts with that at Broomhill (Sheet 65, Geol. Mem.) is interesting from a geological point of view, and is given in the following table:—

	Pit 1.	Pit 2.	Greenwell	Broomhill
Floorstone (thickness) ...	7 ins.	7 ins.	7 ins.	3–4 ins.
Thickness of hard chalk above the bottom of the floorstone ...	12 ft.	10 ft.	not stated	3–3½ ft.
Wallstone (thickness) ...	1 ft.	1 ft.	(?) 1 ft.	1–1½ ft.
Base of floorstone to top of wallstone ...	7 ft.	7 ft.	7–7½ ft.	9–9½ ft.
Upper crust seam ...	9ft. above wallstone 4ft. below chalk	5ft. above wallstone 6ft. below chalk	noted as scattered band of nodules	6ft. above wallstone 6½ft. below topstone

	Pit 1.	Pit 2.	Greenwell	Broomhill
Floorstone to top of chalk	20 ft.	17 ft.	26½–27 ft.	22–24 ft. to topstone 3–5 ft. of flint and chalk above
Wallstone to top of chalk	13 ft.	11 ft.	19½ ft.	13–16 ft.
Material above chalk ...	10 ft.	13–14 ft.	13 ft.	8 ft.

The floor flint is taken as a fixed and recognisable layer in each case. It is 7 inches in thickness in the three Grime's Graves' pits and 3–4 inches at Broomhill.

The topstone at Broomhill apparently corresponds with the flints resting above the chalk in the three pits at Grime's Graves. At Broomhill a layer of hard chalk (3 ft. thick) stained red with iron is 3 ft. below the topstone, *i.e.*, 16–18 ft. above the floorstone. In Pit 1 the walls of galleries 7 and 6 were so extensively stained by iron as to resemble a fresco. This was 15–20 ft. below the top of the chalk. In Pit 2 a layer of pipe clay 1 inch thick was noticed 2½ ft. above the top of the wallstone. This corresponds with the second pipe clay layer at Broomhill 3 ft. above the top of the wallstone.

From these facts it will be seen that the surface of the chalk is uneven, as it is all over the chalk area. The floorstone and wallstone run parallel to each other in the Graves area, but are somewhat further apart at Broomhill. The upper crust layer varies a good deal. The amount of chalk above the floorstone is 26½–27 ft. in the S.E. of the Graves, 20 ft. to the N., and 17 ft. in Pit 2. Lord Rosehill's pit would appear to be of the same depth as the last.

Whether the flint seams are horizontal or are slightly tilted is difficult to say, as the ground slopes up to the E., and the flints resting on the top of the chalk in the three pits are not necessarily *in situ*. The variable depths of boulder clay and sand are an interesting feature, the former being absent at the S.E. corner of the Graves. It is not possible to compare the layers of the fill-in of Canon Greenwell's pit with ours, as no section was published. From his account we note certain facts. The pit was filled in "gradually" from other pits in the neighbourhood. This, in the main, agrees with the facts noticed in ours, in which definite layers mark periods of exposure, in the interval between the "tips." Gradual could only, however, be applied in a limited sense. As is shown elsewhere the filling-in of the shafts is mainly contemporary with the mining.

In regard to the material used to fill in Canon Greenwell's pit, he mentions 18 ft. of chalk in the lower part of the shaft "from between two beds of flint," and above this sand, nodules and small chalk, then chalk and chippings with chalk rubble on the top, but not in distinct layers. As the work extended over three years it would be very difficult to distinguish the layers. A section across the 1914 shafts showed the various tips clearly.

A comparison between the sections of the pits excavated in 1914 is very interesting as the diagrams show. The similarity is remarkable. Though the levels of the various layers are somewhat different, in the main the whole agree.

The three most striking facts are :—

(1) that the lower part of the pit in each case is filled in with large blocks of chalk.
(2) that each pit has a layer of sand or boulder clay running across it.
(3) that each had a living level marked by the black band.

That most of the layers are "tips" is seen from the fact that the highest point of each layer is at the edge. In each the top layer is rainwash, in the bottom of which has accumulated a large number of implements patinated white.

The second layer corresponds to some extent. In each case it was largely made up of dry fine rubble containing masses of shells. Layer 3 in Pit 1 corresponds to the tip 2B in Pit 2. Each was made up of large chalk blocks. In each case the miners lived below this level. In Pit 1 the blocks of layer 5 find a parallel in Pit 2, in the tilt of chalk which divides the two layers of charcoal. After this both pits received a large quantity of sand, below which in Pit 1 is seen boulder clay. In the lower part in each pit there are two layers of chalk thrown in from the opposite sides, and a parallel is also found in the fan-shaped cones of sand from the level of the wallstone. Fireplaces were found in the lower parts of each pit and also in Canon Greenwell's.

The infilling in each case is largely accidental, but the coincidence is rather singular. In all three cases the method of working is the same, the floorstone never being worked below the level of the shaft. In each case the wallstone was used to some extent. Deer-horn picks of similar form (differing from those used in some of the sites mentioned previously) were employed, and to some extent a polished axe. A chipped axe seems also to have been used in Pits 1 and 2 to a smaller degree, of which the marks mentioned previously and the axes found in the shafts of Pits 1 and 2 are evidence. In each case the deer-horn picks were prepared in the same way by cutting with a flint flake, and afterwards by the use of fire. The horns used in all three cases were either shed or from slain animals, and were employed both as hammers to split up the flint nodules and as picks. The tines of the crowns of the antlers were also used in each pit to some extent.

In the method of mining, and driving the galleries there is similarity between the three, both in the width and height of the galleries and doorways, and in the working of the floor flint in apses (semi-circular dome-shaped depressions hollowed out of the sides of the main galleries). The disused galleries were filled in either to the roof or left with an interval for ventilation. The latter system by cutting small squared holes on a level with the floor is not mentioned by Canon Greenwell; however as only three days were available for investigation (as Lord Rosehill states) it is possible

the side walls containing them were not exposed. In each case, too, the neighbouring shafts communicated underground.

In the main the objects found in the shafts and galleries corresponded. In each various pieces of chalk had been carved, and lamps showed no signs of grease marks. The types differed, but the distinction is very slight. The bones from the shafts show a little difference in the list of animals, but in each case it included domesticated animals and wild ones of still living species. Pig would seem to be more numerous in the 1870 pit. As will be seen from the sections dealing with the fauna, pig is doubtful from Pit 1, and only identified by a single tooth from Pit 2. Dog is absent from Pit 1, but present in the other two pits. Red deer comes from a gallery in Pit 1, and a bird's skull from the 1870 shaft.

The levels at which these bones were found differ a good deal. In Canon Greenwell's pit they occur between 4 and 28 ft., and are absent from the lower 12 ft. In Pit 1 bones of domesticated animals were found to 16 ft., but none in the lower 14 ft. of the shaft, whilst in Pit 2 none was found in the lower $11\frac{1}{2}$ ft., *i.e.*, below $19\frac{1}{2}$ ft.

In none of the three pits was any metal found or polished flint. Some deer-horn implements with ground edge are recorded from Canon Greenwell's. Flint and quartzite hammers came from all three. The occurrence of pottery in the 1914 pits may seem to mark a distinction in the period of mining, but the striking similarities between the three shafts in nearly every other particular shows that its absence from the 1870 shaft is probably a coincidence. The means of progression from the surface to the mine were evidently the same in each case, and the detection of thong marks in Pits 1 and 2 throws some light on the method of raising the flint to the surface, whilst the remains of fibre, possibly osier, points to the use of baskets.

For any differences derived from a study of the flora, mollusca, and implements, the reader is referred to the special reports. From the foregoing there can be little doubt that the three shafts were sunk and worked in the same period and by the same race of people, pursuing their occupation in the same traditional way and with the same implements. If the evidence of the bones is admissible, they lived partly by the chase, killing the roe and red deer, and the wild fowl in the fens, and partly on the flesh of their domesticated animals, from which they would also derive a supply of milk. It is doubtful if any race of savages now living could carry out such work as is seen at Grime's Graves. As will be seen, most of the pits are fairly circular, and to cut a circular shaft of these diameters presupposes a great deal of experience and mechanical skill. The former no doubt taught them the angle at which the soft chalk would rest without danger of falling, and they probably learned in the same way that the hard chalk required no batter.

It requires a trained eye to preserve a circular form to a shaft, far more difficult an operation in one of these dimensions than in

those of Spiennes. The same skill is shown in sinking the vertical part of the shaft without dangerous under-cutting. The height and width of the galleries are so uniform within certain limits, one is inclined to think they had some standard of measurement. The main passages would allow two miners to pass each other, and the height of these seems designed to allow a man to carry a load of flint in his arms, or a basket on his back. The ventilation of the mine is carefully arranged by opening up adjoining galleries by means of small holes. The square-topped creepholes, one of which is well seen in the photo of the interior of gallery 1, Pit 1 (Plate VIII.) is not an opening roughly knocked through the wall, but a careful piece of work, the sides of which have been squared. Considerable foresight is seen, too, in utilising the old shafts. A study of other mining sites has shown us that knowledge of the best layers of flint suitable for the making of implements was derived from an outcrop on the surface, or in a neighbouring valley, before deep shafts were sunk from the higher ground, and this fact makes it practically certain that the miners at Grime's Graves acquired their experience in the same way. It has been suggested that this race was accustomed to live in pits, and, having dug one in this area, discovered the flint by accident. This explanation seems an unlikely one when we remember the depth at which the flint occurs. An examination of one of the pits in the field on the W. side of the plantation, or at the extreme S.W. end of the group, might lead to some interesting results. The pits in the latter are generally small, and from the fact of a modern pit being also of small diameter, one might expect them to be of later date. The ground in the field, however, is considerably lower, and a much shallower pit would there reach the seam of flint.

THE FLOORS.

Undoubtedly the floors were the sites upon which the miners manufactured their implements, either for the use of the tribe or for export. That they also carried on their chipping at the edges of the partially filled-in pits is proved by the enormous mass of workshop debris, which came from the sand all round the edge of each shaft, reaching in the case of Pit 1 as far down as layer 5, and to layer 4 in Pit 2, these deposits being alike made up of boulder clay and sand.

The most extensive of all the floors was No. 3, which was worked at three periods. It is no exaggeration to say that the flakes and débris from this floor would fill several carts. The pieces were massed together in very much the same way as were those in the two floors at Peppard; but whereas in the latter, clay formed a matrix which preserved the sharp edges, in floor 3 the chipped pieces were packed together for the most part without any matrix at all. This floor was certainly one of the most interesting sights viewed by those who visited the Graves during the excavations.

Most of the floors were discovered by noticing the numbers of chipped pieces congregated in particular spots, which led to further investigation by digging. The fourteen floors so investigated fall into two distinct groups.*

(A.) Containing massive chipped pieces with primary work only. To this group belong Nos. 2, 3A, 3B, 4, 7, 8, 9, 10, 11, 14.

(B.) Finishing floors; with, in addition to massive primary work, pockets of minute flakes, which were the refuse of the finer secondary work; containing also the finer implements and long narrow flakes. To this group belong floors 1, 3C, 5, 6, 12, 13. All these are quite definite.

The floors in Group A were equally definite with the exception of No. 4, which contained some of the finer work, but in very small quantity.

In all the floors of Group B the coarse pieces, patinated white on both sides, lay on the top. A description of the implements from the floors is included in Mr. Reginald Smith's report.

FLOOR 1.

As indicated in Fig. 1, this floor was located on the north-west face of a pit not far from section 9. This was the first of the floors discovered, and I came across it on March 1st, the day before the digging commenced. The clue was afforded by a quantity of chipped pieces scattered over a small area. On digging with a hand trowel I found hundreds of flakes packed together, lying just beneath the surface. Those lying on the top were white on both faces; those below were blue, but turned white on exposure; and the deeper ones showed two-sided patination when taken out. The deepest of all in this floor were black as in floor 3C. Amongst the larger flakes were quantities of very small ones, and it was evident from this site that implements were finished on the spot and not merely blocked out and exported. The flint, too, was very pure and black and clearly floor flint. Amongst the first pieces found was a flake with trimmed bulb, and a cone with engrailed work. (Fig. 41). It was evident too, that the floor contained many implements broken by misdirected blows or flaws in the flint.

The whole of this floor lay within a foot of the surface below which was 2 ft. of chalk rubble with sand beneath it. It measured 10 by 8 ft.

FLOOR 2.

It will be observed in Fig. 1, that No. 2 forms a group with Nos. 3 and 13, in this part of the Graves. Floor 2 was located on the western slope on the top of a bank. As in several of the other floors there was a group of large chipped pieces on the surface, and investigation revealed it as a chipping area. This floor was 12 ft.

* The tumulus floor is described under the heading of the tumulus. There were in it no massive pieces and no tiny flakes. Most of it was purely débris of irregular pieces, partly chipped and partly split.

in length and 4 ft. across. Its total depth was 1 ft. at the western end, and 9 in. at the eastern end. Some of the pieces were exposed upon the surface, others were covered by moss only. Between the chipped pieces in the floor itself were blocks of chalk without any covering of sand or signs of weathering.

The floor rested upon about a foot of chalk rubble, below which was chalk so tightly cemented together that at first sight it appeared solid. Subsequent cutting through this rubble disclosed sand underneath, and below that boulder clay. Undoubtedly the rubble was material thrown out by the miners. The west end of this floor terminated abruptly on the top of the bank, and was separated by a wide interval from Floor 3, which lay in this direction. Amongst the pieces found here were two fine circular choppers, a thick disc of Drift type, with cutting edge all round, a small hand-chopper similar to many from Peppard, with thick crusted handle, a push-plane, a round-ended adze (Fig. 42), and another with a squared end; also a number of hammers which from their size may be mullers. No fine chippings occurred on this floor.

FLOOR 3. (Plate XXII. and Fig. 9.)

The situation of this floor is indicated on Fig. 1, and its subdivisions in the accompanying section. (Fig. 9). It was discovered on March 21st by the Rev. A. Cross, and afterwards extensively worked by Dr. Allinson and various members of the Society. The floor lay directly east of the Beaver Pit, on the edge of which it started, and extended eastward up the slope. At its starting point it measured 9 ft. across. At 12 ft. from the commencement it measured 8 ft. across, at 15 ft. it showed a width of 6 ft., and its termination at 21 ft. measured 11 ft. in width. Floor 3B extended 6 ft. further eastward. The greatest depth was at the east end. At the west end it was 3 ins., and at this depth Mr. Armstrong found the leaf-blade figured among the implements. (Fig. 54).

When first investigated it was believed that only one floor (3c) lay at this spot resting upon the solid chalk. Later on this apparently solid floor was cut through and found to be rubble thrown out from a pit, and deposited at different periods, for between the two layers was discovered floor 3B. Below the rubble (as was the case elsewhere) occurred sand, and upon the top of this sand lay a quantity of chipped pieces, mostly flakes, thus constituting another floor designated 3A. Floors 3B and 3A were in some places continuous, but in others quite distinct. Floor 3C was for the most part 1 ft. in depth, but in places it dipped to 2 ft. from the surface, and at those points it became continuous with the subjacent floor 3B.

Floor 3C consisted of a dense mass of flakes and chipped pieces including some 14 hammers. In the centre of the area the flakes were extensively burnt and embedded in wood ashes. It comprised the usual contents of a workshop, viz., hammers, cores, broken implements, others spoiled in the making and many perfect ones.

Left : Floor 3 and "Beaver Pit" looking West. Right : Floor 3, looking East.
(Photos taken at end of March by A. L. Armstrong.)

The flakes varied in size. Some were broad and massive, 8 to 9 in. long, others long and narrow. The latter if found together in a separate area might be placed in the Cave period. The best pieces occurred in batches, generally near small heaps of tiny flakes, struck off in finishing the pieces. The implements were found in such numbers that it was impossible to locate their positions on the floor itself, and the best pieces were mostly recognised only when the boxes into which they had been collected were examined. The patina on the pieces is referred to later. Their detailed description is given under "Implements." Two pieces were of special interest, a long blade scraper with fine end work, and a fine celt (Fig. 57) found close to the surface and near the eastern end of the floor, by Dr. Allinson. More than 30 pieces from this floor had facetted bulbs. Floor 3C also yielded some bones of sheep, horns of red deer, and teeth of pig.

FLOOR 3B.

The chipped pieces from this floor occurred in pockets in the centre of the chalk rubble; sometimes in hollow spaces between the chalk blocks, in which case they were chiefly patinated a deep blue. For the most part, however, the floor was spread on one layer of rubble and covered over by another. Except in the hollow spaces referred to, the pieces were all tightly cemented to each other and to the chalk by carbonate of lime, which formed a tenacious coating very difficult to remove except in hot water. As this was a luxury we could not at the time obtain in sufficient quantity, the best shaped pieces were collected in boxes for further examination.

Amongst those which we did wash and examine on the spot, was a triangular axe (Fig. 58), entirely unpatinated, thickly coated with carbonate of lime, similar to one found at Peppard, on site 2. A slightly more finished piece from site 1 (Peppard) is illustrated (Fig. 5) in Archæological Journal, Vol. LXX., No. 277, second series, Vol. XX., No. 1.

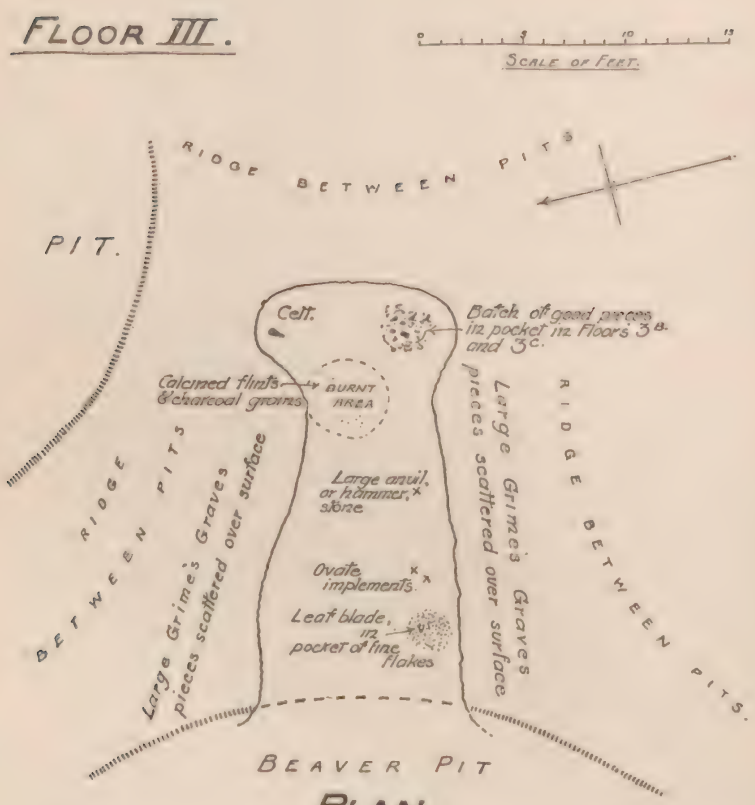
The conclusions that may be drawn from floor 3 are as follows:—

(1.) The floor is an extensive workshop site, where implements were finished, showing that the miners were not bartering the whole of the raw material, but manufacturing on the spot.

(2.) It is clear that none of the pieces was intended to be polished, otherwise some in this condition would have been found.

(3.) The floor was worked at three, or possibly four different periods.

(A.) Before the rubble was deposited, when the area was covered by sand overlying the boulder clay. This is represented in floor 3A. (Other evidence of work on the sand surface is cited under Sections 7 and 13.)



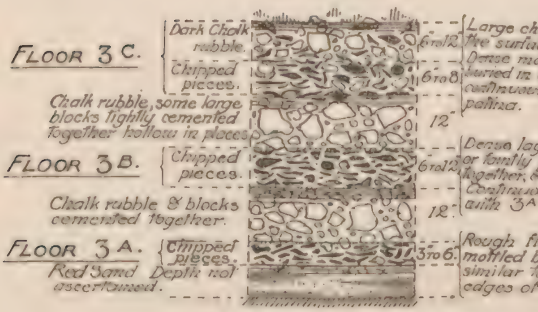

FLOOR 3C.
Dark Chalk rubble.
Chipped pieces.
6 to 12
Large chipped pieces, partly on the surface, patinated white.
Dense mass of chipped pieces, buried in Chalk Pockets in places, continuous with 3B. Two sided patina.
6 to 8
Chalk rubble, some large blocks tightly cemented together hollow in places.
12"
FLOOR 3B.
Chipped pieces.
6 to 12
Dense layer of chipped pieces, black or faintly patinated blue. Cemented together, & removed with difficulty. Continuous with 3C in places & with 3A in others.
Chalk rubble & blocks cemented together.
12"
FLOOR 3A.
Chipped pieces.
Red Sand Depth not ascertained.
3 to 6
Rough flakes, no implements, mottled blue & white patina similar to Sections VII & XIII & edges of Pits 1 and 2.
TYPICAL SECTION.

FIG. 9.

A. Leslie Armstrong. Del.

(B.) After a quantity of tabular blocks of chalk, which must have come from the lower part of a shaft, or a gallery, had been thrown out from a neighbouring pit. Floor 3B represents this period.

(C.) After a second mass of tabular chalk had been deposited, when the most extensive work was done on floor 3C.

(D.) Possibly a later period still when the massive pieces on the top were deposited.

(4.) The lesson from the patination of the pieces is significant and fully borne out by the conclusions formed in excavating the two shafts.

Floor 3A represents the old land-surface, and upon it accummulated the waste pieces of the period, lying there a sufficient length of time to become blue. How long this was we have no means of estimating.

On floor 3B, with the exception of the pieces which lay in hollow spaces between the chalk blocks, all the chipped pieces were black and fresh, with the minute fractures unweathered. Some of them turned faintly blue when dry. Evidently the pieces on floor 3B were buried comparatively quickly, and it is possible that by the dissolution of the covering of chalk, those on the top were exposed for a longer period; which would account for a slight change on their surface.

The pieces on floor 3C showed interesting varieties of two-sided patinas. Those on the surface, or immediately below it were patinated so deeply as to appear white on both faces when taken out. Below these were other pieces, white on the upper face, blue on the under, the blue eventually turning white when dry. Lower still came pieces that were blue above and black below, these turning to white and blue respectively, showing that there was actually a change in both faces, which was accentuated when the moisture was removed. On the chalk were pieces which remained black on the under side and blue on the upper when dry, while those buried in the rubble were black on both faces and did not change at all.

To quote Mr. J. Reid Moir's notes, it is evident that "the patinating agent approached the flints from the surface, expending its force upon those first met with, gradually becoming ineffective as a greater depth was reached." He says further—"It is interesting to note that the flints patinated white, which occur nearest the surface, though showing a colour generally looked upon as indicative of antiquity are not any older, and possibly not so old as those which occur at a greater depth and show a less marked patina, in the same chipping floor."

(5.) The unchanged condition of the flints buried in the chalk at the base of this floor (3C), finally disposes of the idea that such a matrix has any effect upon them.

(6.) It is clear that as the material used was floor flint, a pit with all its galleries, though not necessarily all the pits, was open at the time, which seems to negative any theory that the mines are pre-glacial. This point is further strengthened by the fact that all

the floors are above the sand, and that, though many of them lie scattered on the surface, only one piece showed any signs of striation.

FLOOR 4. (PINE-TREE FLOOR.)

This floor measured 14 ft. E.—W. and 17 ft. N.—S. in the spot indicated on Fig. 1. It lay partly beneath the roots of a large pine-tree, hence the name bestowed upon it. It was first discovered on March 23rd, and a number of good pieces were separated from the waste, but after the discovery of floor 3 most of our spare time was devoted to that spot, and it was not until April 17th that floor 4 was exhaustively investigated. Of 23 pieces then found three were of special interest. One was a large external flake 7¾ in. long, resembling a Moustier chopper (Fig. 64), another a steep-faced massive plane (Fig. 65) similar to one from Peppard, and the third a long, narrow, twisted celt like a Peppard form (Fig. 66). The floor reached a depth of 18 in., and the pieces were mixed with chalk rubble. One flake, triangular in section, was chipped into an end scraper similar to two from floor 3c, showing that these floors are of the same date. Floor flint was used, and the pieces were patinated white on both faces. This floor though not so definite as two others of the group, is classed in Group A, to which it belongs rather than to Group B In the chalk rubble of this floor Lieut. W. Hall found a piece of carved chalk which seemed to have been hollowed out to form a lamp (Fig. 81).

FLOOR 5.

This was discovered and worked by Dr. Allinson. It lay in a depression between three pits, 7 by 7 ft. in diameter. It was quite superficial, in the S.W. corner of the Graves. The chipped pieces lay in and on the chalk rubble, which at this end of the Graves is for the most part exposed, forming heaps of chalk débris entirely bare of sand. A finely-chipped "end of celt," three great axes (Fig. 67), two discs (one thick), three prismatic tools, and a dos abattu knife came from this floor.

FLOOR 6.

This is situated on the S.W. part of the Graves. It was discovered and worked by Dr. Allinson, and was the smallest of all the floors. It consisted of a collection of rough flakes with which was one good piece—a white steep-faced scraper with a flat partly chipped base and parallel fluting prolonged to form a nose, resembling pieces of the Aurignac period (Fig. 68). A good flattened hammer was also found here.

FLOOR 7. (BIRCH-TREE FLOOR.)

This floor lay under a group of silver birch trees, hence its name. I had collected a number of pieces from this spot early in March, but as the roots of the trees made investigation difficult

it was left till more assistance was available for working the floors. It was quite a surface floor, many of the pieces lying actually exposed, but a mass of chipped pieces lay on rubble to a depth of one foot. It belongs to Group A. The most noticeable piece from this floor was a dolphin-shaped steep-faced plane, a form of which duplicates (Fig. 31) were obtained from floor 12 and from layer 2, Pit 2. It resembled an implement from the Peppard factory. The floor yielded, besides, a number of good pieces.

FLOORS 8 AND 9.

These were collections of great roughly chipped pieces lying on the surface in the rubble between the pits. They lay north of Pit 1, between the trees, and were difficult to investigate as the roots form a network at this part. They are indicated in Fig. 1 for future work. Mr. Casey located their position but found no shapely pieces. Their chief interest lies in the fact that they are quite superficial, resting on the rubble with no sand or chalk below, and only a scanty covering of moss. From floor 9 came a white chopper with one flat face, and worked at the end and one side.

FLOORS 10 AND 11.

These were both superficial floors discovered by Dr. Allinson on April 26th and 27th. The pieces in floor 10 lay at a depth of 1 ft. with chalk between; the floor was discovered by digging, no pieces lying on the surface. In both cases the chipped pieces lay in the chalk rubble. Floor 10 measured 8 ft. by 4 ft.; floor 11 measured 4 ft. by 9 ft. Part of a red deer horn came from floor 10, and a large oval nodule used as a hammer from floor 11.

FLOOR 12.

This lay east of floor 7. Its dimensions were 10 ft. by 5 ft. It was found by Dr. Allinson on April 28th, the coarser part of the floor occupying the top of a ridge between two pits and extending 1 ft. below the surface. The finer part of the floor with small chipped pieces and masses of small flakes, extended deeper, about 2 ft., and formed a layer 6 inches thick on the S.W.W. face of a pit slope, N.E. of the main floor. The coarser pieces rested on chalk rubble, but the finer ones lay below it. Amongst the fine series from this floor was a flat pointed implement (Fig. 70), with the base battered at one edge, apparently to facilitate handling. A piece similarly treated came from layer 4, Pit 1. An end of celt (Fig. 74), a quartzite hammer, and a steep-faced plane of Cave form (see Fig. 31) were some of the best pieces from this site.

FLOOR 13.

This was discovered on May 1st, after the excavations had been closed. It lay close to floors 2 and 3, and not far from Section 7. The pieces were lying on the top of a mound separating two pits. The floor ran for a distance of 10 ft. along this ridge, occupying 8 ft. of its width, and extended towards the north on the

southern face of a pit. On this spot were found the best implements; the pieces lay just under the moss, and the greatest depth was 9 ins. to 1 ft. On the top of the bank were quantities of tiny flakes as in floor 3c. This floor belongs to Group B. A number of good pieces included a flat pointed implement with battered edges and spots of iron-staining, of interest, as it was only the third* out of several thousand chipped pieces from the area of the plantation, stained with iron, although on the ploughed fields to the west, iron-staining was common on a large percentage of the pieces.

FLOOR 14.

This was discovered by Mr. Armstrong on March 22nd, and lay on the rubble of a mound between two pits south-west of No. 5, as indicated on the plan. It measured 6 ft. by 4 ft. and belonged to Group A, consisting mainly of rough chipped pieces.

THE TUMULUS.

This mound is situated at the S.E. end of the Graves, and adjoining it is a large pit. These stand by themselves, flat ground separating them from Canon Greenwell's pit, which lies to the W., and from the group of pits, Floor 9, and Floor 13 to the N. It seemed possible that an investigation of this mound might throw some light upon the problem of the date of the mining work, and after consultation with the President, Mr. J. Reid Moir, and the Secretary, Mr. W. G. Clarke, we commenced a section. Previous work carried out by the Norfolk and Norwich Archæological Society before 1870, as mentioned by Canon Greenwell and Lord Rosehill, had disclosed nothing except some red deer horns, but this result did not deter us from making a fresh experiment.

Regarding theories as to the origin of the mound, the Rev. F. Blomefield's remarks have already been freely quoted (p. 13). These suppositions, however, do not explain the origin of the mound itself, and for this there would appear at first sight to be two explanations:—

(1.) That it is a burial mound, possibly of the miners themselves, or of earlier or later date than the mines.

(2.) That the mound is the débris thrown out from the first pit that was opened, each successive pit as it was abandoned being refilled by the material taken out in digging the next. Hence, on this supposition, we have here the spot where the mining in this area was first begun. The earlier failure to find an interment favoured this.

* The other two came from layer 1, Pit 2, and from the section of the tumulus.

There are, however, objections to both these theories. With many tumuli there is no sign of the soil having been taken from the adjacent surface. (This fact is mentioned by Canon Greenwell in "British Barrows.") Where an indication does occur, a slight hollow can be observed all round the mound. This method of procedure economises labour, and for the reason that the Grime's Graves' mound has no such indication, it seems unlikely it was sepulchral.

The material taken from all the other pits is piled round their circumference to form a ring. In the case of the tumulus pit, around which there is plenty of spare ground, we should expect to find the same thing, unless the ground had been levelled at a subsequent period, of which there was no indication. It is also possible the N.E. and W. sides were purposely left open to allow shafts to be sunk in these directions. Of course it is also possible that, having experimented here and found the flint thinned out to the E., they sunk their next shaft some 24 yards away to the W., and coming upon a suitable thickness of floor flint, followed it. Against the theory that at this spot the first shaft was dug, and that the material from the next was thrown into it, is the breadth of spare ground between the tumulus pit and the next one. It seems unlikely that material, which was probably carried in baskets, should have been taken so far when so large a space for dumping it was available close by. A section across the centre of the tumulus pit would have settled the point, and the work was commenced under the superintendence of Mr. W. G. Clarke. Work here was abandoned, however, Pit 2 having proved to require all available labour, if the bottom was to be reached in the time at our disposal. It is to be hoped that the matter may be further investigated on a future occasion.

The tumulus forms a nearly circular mound. With the adjoining pit it has a long diameter of S.S.E. by N.N.W. From its approximate centre the measurements are E. 49 ft., W. 33 ft., N. 42 ft., S. 36 ft. Total diameters: E.—W. 82 ft., N.—S. 78 ft. It is very difficult to measure accurately because the edge fades away imperceptibly. The centre is flattened into a platform, and there are traces of the recorded work of the Norfolk and Norwich Archæological Society, consisting of a trench cut from the N. to the apparent centre. Adjoining is the tumulus pit which lies to the N.N.W. The ground falls away to the N.N.E. and the N.E., rising again further on. There are no pits in this direction, and a section dug here (Sections 17 and 18) shows a thick layer of sand, and an absence of the white patinated flints which cover the Graves' area. On its N.E. side there is a large cup-shaped hollow in the mound.

Our experimental work was begun on April 27th. Taking the centre of the mound at the point where the previous excavations had ceased, three men were set to work on trenches which should meet at the centre, one starting from the S., the others from the E. and W. In each case the top soil measuring 1 ft. showed chalk blocks mixed with surface soil.

In the E. section 2 bones, identified as sheep, were found in chalky rubble 1 ft. deep, at a distance of 10 ft. from the eastern edge. The rubble contained quantities of flakes—blue turning white—and topstone nodules with frost fracture; also a few quartzite pebbles.

On the E. below 1 ft. we found chalk blocks evidently thrown out from a pit, and the same on the W. side, where sand lay beneath the blocks and rubble at 1 ft. 9 in. This seemed to support the theory that the mound was merely the débris from the adjacent pit. In all the other pits, however, as already mentioned, we found a ring of blocks, rubble and sand piled up round the mouth, and it was difficult to understand why this particular pit refuse was treated differently, that is piled in one heap, when it would have greatly saved time and trouble to pile it round the pit, unless it was due to their intention of mining to the N., E., and W. of the pit. However, the N., E., and W. were quite clear.

On the Anglo-Saxon theory or tradition, it was to be expected we should find something of that date, but we did not. In the west section we found some red deer horns in a fragile condition, and near the western edge, 1 ft. deep, 3 horse incisors and 3 hammerstones patinated dull white. In the south section there was a small piece of coarse pottery 1 ft. below the surface near the centre of the section, and at 3 ft. 2 hammerstones, one a dark iron-stained rolled ball, the other white.

The work on these three sections seemed to progress very slowly, and as there was not much time left, I decided on April 29th to abandon the W. and E. trenches and concentrate the three men's labour upon the S. (Section 16.)

Here at 4 ft. another piece of coarse pottery came to light near the centre, while 3 ft. from the S. margin and at 2 ft. in depth, a sheep's tooth lay in the rubble. At 2 ft. 6 in. and 3 ft. were found two pockets of acorns and beechmast, evidently a burrowing animal's winter store. This showed how bones might get in from the surface, and lead to erroneous conclusions. Our object was to reach the original surface-level, and to drive our trench to the centre on that level. It soon became apparent that we had a stratified mound, the top, made-soil with chalk blocks, and below this chalk rubble, with a layer of boulder clay. Having found the sand at the extreme S. margin we began to follow it. Upon it lay a quantity of dark blue flakes, which turned white on exposure.

Following this floor of sand, at 9 ft. from the S. margin, and 4 ft. below the surface of the mound we found a large quantity of irregular flints (topstone), evidently thrown there by man. Mixed with these were pieces of rounded chalk rubble, about the size of an orange. The flints were piled mostly without any matrix, and the whole formed a domed mass above the sand. In the hollows were masses of carbonised roots, which at first suggested an interment. This layer was 2½ ft.–3 ft. in thickness, and we cut through it, following the sand beneath. We were unable to ascertain whether a continuous ring of flints ran round the tumulus, but they

disappeared into the sides of the section. At that time we thought they were waste thrown out from the pit, but in view of the nature of the mound, I think they were an intentional ring.

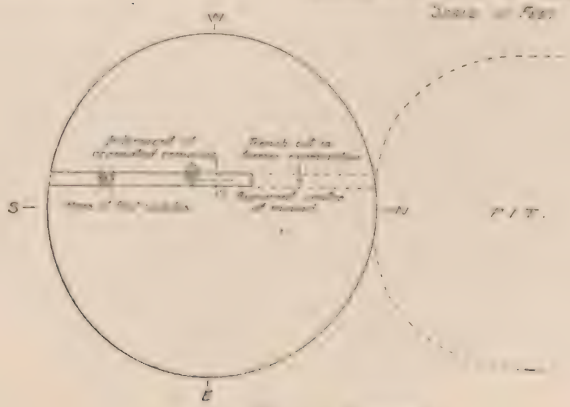
At 10 ft. 6 in. from the S. margin we came upon a floor of chipped flints. They lay on the sandy surface on which the tumulus was raised. It was as if one had come down on a knapper's heap. The flints were quite fresh, black, and sharp. Some of them on exposure turned bluish, indicating some exposure after they were chipped by human hands. Others were black on the under surface and blue above. The pieces consisted of cores, flakes (mostly irregular), splinters, and irregular pieces. Some flakes measured 6½ inches, and many were crusted. Steep-faced cores or planes, undercut or engrailed, and some symmetrically chipped pieces were amongst them. The style of chipping was coarse and broad, tending rather to breadth than length, but many large flakes were included. The whole facies was similar to the Graves culture.

An interesting point was the number of flakes that had a facetted bulb, and many had fine work on the striking-plane though the flakes themselves were irregular. One flake had alternate flaking on the ridge forming a dos abattu, and there were many hinge fractures. These pieces are apparently of the same date as the surface pieces from the Graves; they are made from floor flint, grey in parts, taken from the mines. (We found this flint in the mine was not always pure). Clearly no patinating agent had been at work whilst they lay buried, but there was some lustre on the pieces. They show quicksilver spots but no iron-staining. The position in which they lay was not exposed to sun, nor to CO_2 from rain, nor could rain have penetrated through the boulder clay; they were, however, damp. Stress is laid upon these details as having an important bearing upon the question of patina.

Continuing our cutting into the mound, which grew deeper as we proceeded, we followed the line of sand on which lay the chipped flints, and at a distance of 25½ ft. from the S. margin of the tumulus came upon a thin layer of burnt material, occupying a space of 2½ ft. E.—W. by 4 ft. N.—S. Mixed with this black burnt material were black flakes, some fired—from the floor we were following. Underneath was a layer of chalky rubble, and sub-angular gravel, made up of old patinated frost-fractured flints. Where this gravel came from we have not determined. The burnt interment was 10 ft. below the top of the mound, the layers above it being indicated in the accompanying section (Fig. 10). Supposing this interment to have been made in the centre of the original mound, the size of the original tumulus would have been N.—S. 25½ ft. (the distance from the S. margin to the edge of the interment), plus 25½ ft. presumably on the N. side, with 2½ ft. for the space occupied by the interment itself—a total of 53½ ft. We found by measurement the N.—S. size of the present mound to be 78 ft. (or a little less). Consequently the mound must have been added to by material thrown out from the adjacent pit. The E. margin of

TUMULUS.

Fig. 10.



PLAN OF TUMULUS.

SECTION XVI.

A. – Humus.
B. – Chalk rubble & sand.
C. – Boulder clay.
D. – Red sand.
E. – Gravel & fine sand covering interment.
F. – Interment & cremated remains & charcoal.
G. – Chipping floor containing implements.
H. – Boulder Clay & sand.

the mound measured 39 ft. to the edge of the interment; the W. margin 26 ft. to the W. edge of the interment, which measured 4 ft. across—a total of 69 ft. The present measurement E.—W. is 82 ft. at the apparent centre, some 11 ft. to the N. Consequently the mound if originally symmetrical has been added to at the E. and W. sides. The majority of the addition however is to the N. nearest the adjacent pit.

Just N. of the burial on the same level and in the chipped floor occurred a bone which Dr. Andrews identified as ox. The flakes and workshop debris filled two good-sized wooden cases. The floor continued to the apparent centre of the mound, and beneath the sides of our section. The section showed the signs of the original mound running down on the N. with the added material above, bearing out conclusively the theory that the original tumulus was smaller.

We followed the section to the apparent centre of the mound, and found that the sand there rose higher with its floor of chipped black flints (2 ft. thick) to 6 ft. from the top of the mound. Below this the boulder clay rose up also. Above was moved chalk rubble where the former section had been made. It seems that the former excavators had opened the mound from the N. cutting through the later-added material. They reached the sand with its chipped floor at the apparent centre, and missed the interment. Had they cut in from the S. or continued their section through the entire length they would have come upon the interment. Mr. W. G. Clarke found in the burnt material fragments of burnt pottery, probably the cinerary urn. Mr. A. Leslie Armstrong sends details of similar interments from Yorkshire.

CONCLUSIONS FROM THE TUMULUS.

The mound is raised over a burnt interment, the fire having destroyed the urn. The original mound was about 53½ ft. N.–S., 49 ft. E.–W. The present mound is about 82 ft. E.–W., 78 ft. N.–S. The mound was enlarged subsequently by material probably thrown out from the adjacent pit. The original surface of the ground is represented by sand. On this sand is a workshop floor. The place of interment was prepared by placing sandy gravel, brought from a distance, on which the funeral pile was built.* The ground at that time was strewn with workshop debris. A layer of sand was piled over the pyre, and then a layer of boulder clay. This would result naturally from digging at this spot where sand overlies boulder clay. Subsequently—possibly when the pit was being excavated—chalk rubble was thrown over. Possibly a ring of large flints was thrown round the margin. The interment was made and the mound raised after the flints were chipped. There is no evidence of use in Anglo-Saxon or Roman times.

Of the bones found during the working of this section all except one were superficial, and belonged either to the period when the

* A small patch of gravel is seen in the boulder clay pit on the S.

mound received its additions or to any subsequent period. Thus sheep and horse were 2½ ft. below the surface. The part of a long bone found 6 in. N. of the interment is clearly of the same date, and was identified as ox. It was not complete, and whether *B. urus*, *longifrons*, or *domesticus*, it is impossible to say. Canon Greenwell mentions in "British Barrows" that in the barrows of the Wold, bones of *B. longifrons*, and of a cross between this and *B. urus* have been found. In regard to the patch of gravel found beneath the interment, Canon Greenwell mentions that he found a cist in one barrow which had the floor lined with pure sand, this occurring only at a distance of seven miles, and having probably been introduced. In another interment pebbles were found, which had been brought from the bed of a stream 2½ miles away. In the case of the Grime's Graves tumulus, the pyre was placed on the surface, and no shallow grave was dug. This is in agreement with Canon Greenwell's experience in Yorkshire, but opposed to that of Mortimer in the same county.

THE SECTIONS.

The greater number of these sections, 17 in all, were cut in the hope of throwing some light upon the most elusive problem of the Graves, viz., where the mining commenced. It is clear that the miners would not have sunk shafts through sand and boulder clay unless they knew that the chalk was not very far below. (*See* Mr. Reginald Smith in "Archæologia," Vol. LXIII., p. 144). The most likely spot for them to experiment with would be one where the chalk cropped out on the surface, such as occurs close to the Brandon-Mundford road just at the point where the trackway turns off to the Graves. To find an outcrop of this kind was our main object in cutting eight of these sections, wherein we were unsuccessful.

Sections 1, 2, 5, 6, 8, and 17 gave negative results, showing however that the Grime's Graves culture is very local (Section 17). We learn from these sections that on the W., N., and E. sides of the Graves sand over-lies boulder clay, and that in none of these directions does the chalk rise to the surface. On the ploughed field to the W. at 282 ft. from the plantation and beyond (Section 1) no pits had been dug, and the same applies to the E. and N.E. sides. Time did not allow us to find the limit to the N. The amount of sand in these different directions varied a little. In Section 1 (the lowest down the slope) it was 1 ft. in depth; higher up the slope in Section 2 it measured 1½ ft. To the N.E. (Section 5) where the ground had been ploughed many years ago, the sand formed a layer 2½ ft. thick upon the undisturbed chalky boulder clay. A little to the north upon the east side of the N.E. group of pits there was 1 ft. 9 in. of sandy top-soil. The section to the E. of the whole group gave 1 ft. 9 in. to 2 ft. of sand. Permission to work upon

the S. side of the plantation not having been asked, we were unable to ascertain the depth of sand in that direction. Judging from Canon Greenwell's pit it was greater.

In each case, beneath this sand, which Prof. Kendall pronounced to be decalcified boulder clay, we found undisturbed chalky boulder clay, of which the total depth was not ascertained. In the field to the W., however, we probed it to a depth of 3 ft. 7 in. (Section 1), and 4 ft. (Section 2). In Pit 1 we found the sand varied in two sections from 1 ft.—3½ ft., and the boulder clay was 2 ft.—4 ft. in thickness. The main result of Section 8 was to show that the old surface lay 3¼ ft. below the present level.

The relative amounts of rubble, sand, and boulder clay in Pit 2 could not be measured accurately, as we were anxious not to weaken the line of our cut-edge. This cut-edge showed ½—1½ ft. of boulder clay, above which was 5 ft.—6 ft. of sand with chalk rubble varying from 2 ft.—5 ft. Our cut, however, was not carried back to the original opening of the shaft because this would have involved considerable time and expense, hardly commensurate with probable results, and it is easily recognisable that the ½ ft.—1½ ft. of boulder clay seen might be only the thin end of an inclined plane.

To clear up the matter we cut a section, No. 10, in the edge of the adjoining pit to the N.E. This gave us 2½ ft. of red sand and 6 ft. of boulder clay. The latter was even thicker, as we had not reached its base when we ceased cutting at the bottom of the grass cup. Corroboration of the thickness of the boulder clay is also visible in Section 13 (Fig. 11), cut between Pit 2 and the adjoining pit to the N.E. Here the boulder clay rises up at either side, leaving a gulley between the margins of the two pits, afterwards filled artificially. Sections 14 and 15 on the N. and S. lips of Canon Greenwell's pit showed 6½ ft. of red sand, and a total absence of chalky boulder clay, and in face of these sections it is difficult to see how Canon Greenwell arrived at his measurement of 13 ft. To sink through 6½ ft. of sand is a very different undertaking to that which 13 ft. implies.

Sections 3, 4, 7, and 9 disclosed the fact that where these were situated pits had been dug, though their traces had been nearly, or entirely, obliterated on the surface. Professor Ridgeway (Cambridge) when visiting the excavations recollected having seen a number of pits in the open fields west of Grime's Graves, many years ago, where it is now ploughed land. This explains the great quantities of implements of Grime's type in the field west of the Graves, which has long been a happy hunting-ground for collectors. Section 4 disclosed a pit, although surface indications were entirely obliterated, but whether the pits extended much further in this direction we had not time to ascertain. As the whole of this open part is strewn with chipped pieces, it is probable that the labyrinth of galleries extended here also. The spot was selected for section-cutting mainly because I found there on the surface the white patinated racloir having strong Moustier affinities, now in the British Museum.

The other sections are dealt with in the detailed descriptions which follow, Section 16 being included in "The Tumulus."

SECTION 1.

A trench measuring 2½ ft. by 3½ ft., situated at a point 567 ft. from the fence on the S.W. side of the Graves. Its position is indicated on Fig. 1. The surface soil contained only a few rough chipped pieces, patinated white and blue. Beneath this, 1 ft. from the surface, was the undisturbed boulder clay, with no chipped pieces. This was found to extend downwards for 3 ft. 7 in. without the chalk being reached. By this section made on the sloping E. face of the field lying W. of the plantation containing the Graves, we found that no pits extended in this direction.

SECTION 2.

Trench 2½ ft. by 3½ ft. Position 282 ft. S.W. of the wire fence of the Graves. The ground here sloped 10° from E. to W. The surface was ploughed. The section showed 1½ ft. of dark sand containing a few roughly chipped pieces, patinated white and blue. At 1½ ft. from the surface the boulder clay was undisturbed. We probed this for 4 ft. without reaching chalk.

SECTION 3.

Trench 2½ ft. by 3 ft. This section indicated on Fig. 1 was made at a spot where a faint ring with a depression in the centre seemed to mark the site of a pit. Our section was dug through what proved to be the encircling mound of the pit, the top of which had been obliterated partly by the plough and partly by sand blown across it. At 1 ft. below the surface a thickness of 3 ft. of chalk blocks was encountered resting on red sand. This is the sequence observed in other pits. The chipped pieces found were of a dull white like those from the surface of the Graves. Further in the field where the sand is thicker they are lustrous.

SECTION 4.

This section was made due N. of the hut, *i.e.*, about the middle of the N. boundary of the Graves plantation, in the field which slopes into the valley running down in the direction of Brandon. It was evidently under cultivation at one time, but is now fallow, and covered in part with bracken and other heath vegetation. The portion in which the section was made had been cultivated for a potato crop within the last 20 years. The surface is studded with rabbit holes and covered with a profuse layer of white patinated flints, mostly frost-fractured, but also largely chipped débris similar to that covering the area of the plantation. The section measuring 7 ft. by 3½ ft. disclosed 3 ft. of chalk rubble containing some horns and bones. Immediately below this was a 1 ft. layer of charcoal, with chalk blocks underneath. It was clear we had here a pit which had

been smoothed over, with a layer of charcoal representing an occupation level 3 ft. from the surface. Probably the whole of this area as far as the bracken was covered with pits.

SECTION 5.

This section (3½ ft. by 5 ft.) gave negative evidence. It showed us that the chalk was not near the surface. The usual order occurred—1 ft. dark sandy top-soil, 1½ ft. yellow sand, decalcified boulder clay, and beneath this the tough boulder clay itself, the depth of which we did not ascertain. The section yielded no implements or bones, and no chipped débris.

SECTION 6.

This section was made E. of the N.E. group of pits, and 100 ft. distant from the pits themselves. No pits appeared further to the E. or N.E. of this space. The trial hole measured 3 ft. by 5 ft. The top-soil was sandy, 1 ft. 9 in. in thickness. There was only a pocket of sand dipping into the chalky boulder clay and not the usual layer seen elsewhere. The section showed that the chalk did not occur near the surface here, nor did the pits extend to this spot. It yielded no implements or bones and no flakes.

SECTION 7. (Fig. 11.)

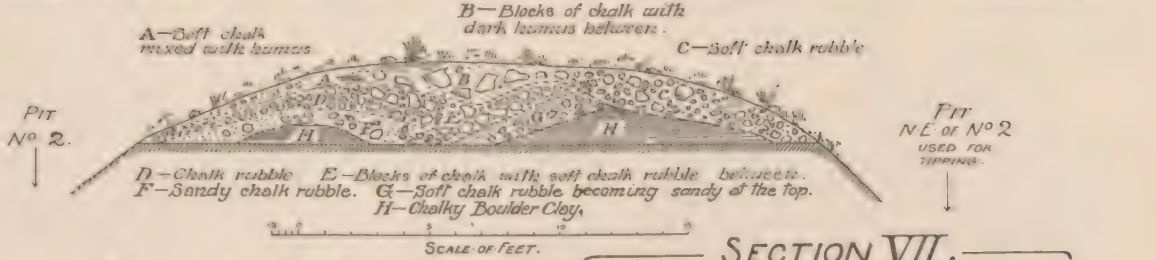
Between the N.E. group of pits and the tumulus with its adjacent pit, was flat ground, partly traversed by a grass road as indicated in Fig. 1. A section was made at this spot to ascertain the depth of sand and boulder clay, and if possible find the chalk itself. A trench 4 ft. by 6 ft. was cut, and a depth of 9 ft. was reached. The dark sandy top-soil varied from 1 ft.—2½ ft., and contained chipped pieces of Grime's type. All were large pieces, patinated white on both sides, and stained with manganese. The best was a circular disc with a good deal of crust on one face. In the sand were some nodules of flint. Below this resting on pure reddish sand was a floor of chipped pieces, evidently the surface of the ground contemporary with the mines. The flakes were sharp, blue-white, turning white on exposure, and corresponded with those from the sandy edges of the two pits excavated, and the other points where we dug into the miners' level. A hoof core and a flake five inches long came from this floor.

The sand above-mentioned varied very much in the sides of the section. On the E. side it was 1 ft.—1½ ft., increasing in thickness towards the W., where it was still to be seen in the floor of the section at a depth of 9 ft., *i.e.*, it varied from 1 ft.–1½ ft. to 7 ft. in thickness. It contained no chipped pieces, but plenty of thermally fractured flint. Below it was chalky boulder clay (unmoved) which occupied the rest of the area and showed in our section a maximum depth of 5 ft.

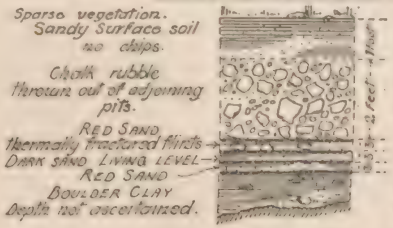
On April 30th, while measuring before closing the section, I examined the sides more closely, and in the W. face found a piece of sheep bone and some charcoal and pot-boilers 1 ft. below the

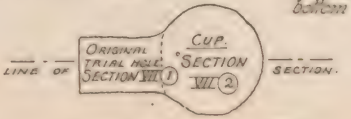
SECTION XIII. GANGWAY CUT FROM PIT 2 TO PIT N.E. OF IT.

FIG. 11.


A—Soft chalk mixed with humus
B—Blocks of chalk with dark humus between.
C—Soft chalk rubble
PIT No. 2.
PIT N.E. OF No. 2 USED FOR TIPPING.
D—Chalk rubble E—Blocks of chalk with soft chalk rubble between.
F—Sandy chalk rubble. G—Soft chalk rubble becoming sandy at the top.
H—Chalky Boulder Clay.
SCALE OF FEET.

SECTION VIII.

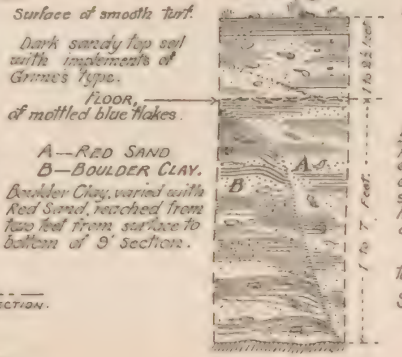

Sparse vegetation.
Sandy Surface soil no chips.
Chalk rubble thrown out of adjoining pits.
RED SAND thermally fractured flints
DARK SAND LIVING LEVEL
RED SAND
BOULDER CLAY Depth not ascertained.
2 Feet



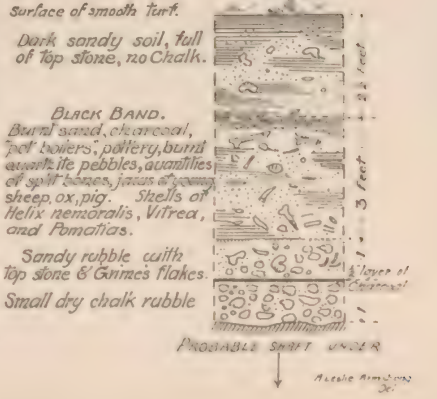
PLAN OF SECTION VII.
SHOWING POSITION OF SECTIONS VII. (1) AND VII. (2)
SCALE ——— OF FEET.

SECTION VII.

VII. (1)


Surface of smooth turf.
Dark sandy top soil with implements of Grimes type.
FLOOR, of mottled blue flakes.
A—RED SAND
B—BOULDER CLAY.
Boulder Clay, varied with Red Sand, reached from two feet from surface to bottom of 9' section.
1 to 2½ Feet.
1 to 7 Feet.
A
B

VII. (2)


Surface of smooth turf.
Dark sandy soil, full of Top stone, no Chalk.
BLACK BAND.
Burnt sand, charcoal, pot boilers, pottery, burnt quartzite pebbles, quantities of split bones, jaws of roe, sheep, ox, pig. Shells of Helix nemoralis, Vitrea, and Pomatias.
Sandy rubble with Top stone & Grimes flakes.
Small dry chalk rubble
2½ Feet.
3 Feet.
1 layer of Charcoal
PROBABLE SHAFT UNDER

surface. On cutting away this side it was discovered that our section had been made on the edge of a cup-shaped living-place which might be described as a hut circle, measuring 8 ft. in diameter. This edge yielded a quantity of bones and pot-boilers, and some pieces of pottery, with *Helix nemoralis*, and charcoal. Many of the bones were split and burnt, and from the absence of epiphyses were evidently those of young animals used for food. There were also small jaws of sheep or goat with teeth uncut, and portions of skulls with miniature horn cores. With these were bones of red and roe deer.

The charcoal relic layer was seen to dip downwards to the W., and I had a large piece of top-soil removed. Here the black layer measured 3 ft. by 3 ft. at 1 ft. to 3½ ft. from the surface. Subsequently we reached the centre of this burnt layer and found it was 5½ ft. below the present surface-level. The accompanying section (Fig. 11) shows the order of the layers.

In the centre of this section we made a deeper hole and found 1 ft. of mixed sand and chalk rubble, with some larger chalk blocks. Among these were large flakes and irregular chipped pieces similar to the Grime's culture, with large flint nodules of top-stone. This layer was a foot thick, and beneath it was another distinct thin layer of charcoal, 1½ in. thick. We went another foot deeper and found 1 ft. of small chalk rubble, similar to that found in Pits 1 and 2, layer 2. This rubble was fine and dry and was evidently chalk disintegrated by frost. We came to the conclusion that we had here another shaft, which had been levelled over in making the road.

Mr. W. G. Clarke and Mr. E. T. Lingwood helped to complete the work of clearing this site, after the main digging was finished. It proved to be very rich in certain things, notably bones, but practically destitute of flint work. A few black flakes, some of them burnt, were mixed with the charcoal and bones, but not a single piece showed secondary work. Moreover, the character of the chipping did not correspond with the Grime's pieces. A broad piece resembling a rough adze, with one flat face patinated blue, came from the soil above.

Amongst the mass of bones was one of roe deer, which had been artificially split and sharpened, to form an implement (Fig. 85), and Mr. Lingwood found that the natural projection on its broad end exactly fitted the ornament on one of the pieces of pottery (Fig. 82), whilst the shaft of the implement corresponded with the perforation in the side of the same piece. A second bone pin (Fig. 84), artificially hollowed and polished, was found afterwards, the bone from which it was made being identified by Dr. Andrews as sheep. While washing the bones, Mrs. Lingwood later on discovered a third bone pin.

A long bone of red deer was found to have five cuts in it (Fig. 86), and one of young ox had 15—20 parallel black lines across the shaft; other cut bones were a vertebra and rib of ox, and a long bone of sheep.

The end of a long bone of red deer was hollowed artificially,

another long bone was sharpened at each end, and part of a sheep bone was polished at the ends.

The amount of pottery at this site was considerable, and includes the bases and rims of vessels, ornamented with embossed (Fig. 82) and other patterns (Fig. 83); two of them were perforated. A large quantity of pot-boilers was scattered through the charcoal band. Most of these were of flint, whitened and cracked by repeated use; many were of circular form. In addition there were numbers of quartzite pebbles which had been split by fire, and were probably collected from the boulder clay or sand, for the same purpose. The pottery, cut bones, etc., are separately described.

It is instructive to make a comparison between the cup-shaped black bands in Pits 1 and 2 and this section. In Section 7 this layer was 3 ft. thick in the centre. The base of it lay $5\frac{1}{2}$ ft. below the present surface, the edges rising to only 1 ft. below.

In Pit 1 the black band had a maximum thickness of 1 ft. and reached to 10 ft. below the original centre of the grass-cup surface, *i.e.*, 14 ft. below the highest point of the encircling mound.

In Pit 2 the black band was double, each layer being 1 ft. thick, the lowest point reached being $12\frac{1}{2}$ ft. below the original surface of the cup, *i.e.*, $19\frac{1}{2}$ ft. below the top of the encircling mound. Another small fireplace occurred 7 ft. below the surface of this pit.

In contents, the bands of Pits 1 and 2 roughly corresponded, and were clearly contemporary. The most marked difference between these pit-layers and Section 7 lay in the presence in the former of complete implements, corresponding in style of work with the rest of the Grime's culture, while in the latter there were no flint implements, and only a few small flakes, either black or faintly blue.

Another marked feature in Section 7 (in the cup of it) was the great quantity of blue-white pot-boilers, of which we collected a large box-full. Many of these were small fragments, others rounded, about the size of a large walnut. These pot-boilers are similar to those found in surface floors, notably at Nettlebed, Oxon. The burnt flints, of which there were comparatively few in the black bands of Pits 1 and 2, were large and irregular, and not a single ball-shaped piece came from these layers.

In Pits 1 and 2 there were no bone implements of any kind, whereas in Section 7 (as previously mentioned) there were several cut bones (Fig. 86) and three well made bone pins (Figs. 84, 85). From Section 7 came a quantity of pottery (Figs. 82 and 83 in Mr. R. Smith's report) mixed with charcoal and pot-boilers, whereas no pottery was found in the black bands of Pits 1 and 2.

Section 7 is therefore of great interest, because it shows that some of the disused pits were utilised as dwelling-places at a later date than the working of the mines. Thus we have in Section 7 two separate cultures super-imposed, and further work upon this site should emphasise the point.

SECTION 8. (Fig. 11.)

A trench dug in the flat platform between a group of pits E. of Pit 1. This section, which measured 3 ft. by 4 ft. gave us 1 ft. of sandy surface soil, 2 ft. of rubble, and 3 in. of red sand filled with thermally fractured flints (proving it not blown). At 3¼ ft. a band of dark sand, 3 in. thick, occurred, and seemed to be the living level. The boulder clay lay below. In this section the sand was only 9 in. in all, and of this 6 in. only appeared undisturbed. We learn from this section—

(1) That the original surface lies 3¼ ft. below the present level.
(2) This area was undisturbed, but has some rubble from the neighbouring pits thrown upon it.
(3) The red sand containing thermally fractured flints may be sand from another pit.
(4) The original surface is dark.
(5) Below is the decalcified boulder clay only three inches thick.
(6) Below that is the boulder clay undisturbed.
(7) In all, the sand is only 9 ins., and 3 ins. of that was probably introduced.

N.B.—The term "original surface" is intended to designate the surface of the period at which the miners lived and worked.

SECTION 9. (Fig. 12.)

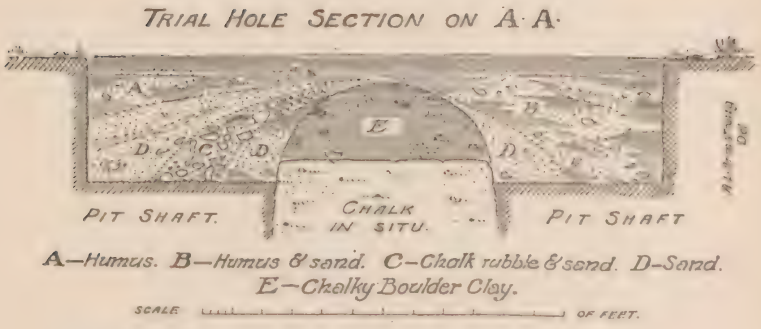
In walking across the area of the Graves it becomes apparent that the method of sinking the shafts was not always the same. Some of the pits are isolated, others in serpentine lines, and others in trefoil or quatrefoil depressions.

Canon Greenwell and others have suggested that the depressions, which run in wavy lines, were galleries which had fallen in. Canon Greenwell tells us that galleries were driven into the chalk, 3 ft.—5 ft. high, at a depth of 40 ft. from the surface. He recorded 13 ft. of sand resting on the chalk, so that a solid mass of some 22 ft.—24 ft. of chalk would have had to give way if this theory were correct. It was possible, however, that the galleries were not so deep down on this side of the Graves.

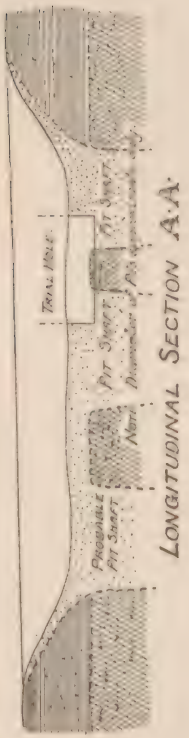
An examination of one of these serpentine dykes convinced me that three pits had been dug in a line, and in order to test the matter, while waiting on March 18th for some poles with which to erect a platform across Pit 1, we cut a section, 18 ft. by 2½ ft., in the long diameter of one of these dykes, situated in the N.E. part of the Graves. In the accompanying diagram (Fig. 11) two views are given of the section.

The parallel walls of the dyke rose 10 ft. to the N.E., and 13 ft. to the S.W. They formed broad plateaux separating a similar line of pits to the S.W. from a small isolated group to the E., the latter being the limit of the mining area in this direction.

As our diagram shows, we reached the solid chalk through 3 ft. of chalk rubble, and found flints resting on the top, as in Pits 1 and 2. Our section at this point showed a wall of chalk 6½ ft. across



TRIAL HOLE SECTION IX.



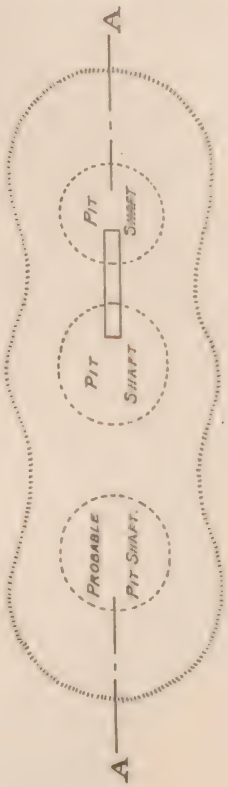


FIG. 12.

which rose between two adjoining pits. Above the chalk was boulder clay. From the pit edges thus defined we estimated the size of the adjacent shafts: that on the N. measured 30 ft., that on the S. 26 ft. These pits would be larger in diameter than Pit 1, which measured 20 ft. at the level of the chalk. There was a surface indication of another pit at the end of the dyke of about 37 ft., and the line of the dyke continued round to the W. Very little came to light in digging this section. The re fill of the N. pit was found to consist of 2½ ft. of dark sandy loam, from which we obtained part of a bone and a few white flakes: below it was red sand. The S. pit was filled at its mouth with chalk rubble lying at an angle of 20°.

We see clearly what had happened at this spot. The miners had sunk a line of shafts; in the case of the two we investigated 6½ ft. apart. These had been dug through boulder clay and sand, but as it was dangerous to leave a narrow wall of these materials between adjacent pits they had been removed and piled on one side (probably the E.). In doing this, labour would be economised by tipping from one shaft into another. Although the rims of the two pits are separated by only 6½ ft. of chalk at the top, the wall would probably batter (as in the case of Pits 1 and 2) until the tabular chalk was reached, in this way attaining a thickness which precluded any danger of this dividing wall between the pits collapsing, which might easily happen had it been left as a vertical mass of chalk for about 27 ft.

It has been suggested that the first mine was sunk at this end of the plantation, the tumulus itself representing the material thrown out in digging the first shaft, after which the empty pits were used as dumping grounds. Our section through the tumulus hardly bears out this view, but the nearness of the two shafts disclosed in Section 9 is certainly suggestive.

At Cissbury some of the pits had no galleries, and the same absence is noted in the one at Chichester described by Capt. Wade. Doubtless the art of driving galleries was only acquired by experience, and it is possible we have herein an explanation of the nearness of these two pits. On the other hand the flint at this spot might have been very abundant, and the miners anxious to get out as much as possible. At the same time the areas beneath the plateaux to the N.E. and S.W. may have been reached by galleries from the two adjacent shafts.

SECTION 10. (Fig. 13.)

To the N.E. of Pit 2 lies one of the largest pits in the whole group of Graves. It is not only bigger than Pit 2, measuring 42 ft. by 43 ft., but its cup was also deeper. Pit 2 was 7 ft. deep when we commenced.

In the W. face of this large pit, from top to bottom, we ran a trench 14 ft. long and 3 ft. broad. The top of the mound was found to consist of large tabular chalk blocks. They must have come from low down a pit shaft or from a gallery. They were

covered with turf, but were not broken down by frost as might have been expected. Below them was chalk rubble either from the chalk layer above the tabular or from a gallery, or else split up by rain and frost. Below all this, which measured as a layer 2 ft. 9 in., came a couple of inches of hardened cement-like sand and chalk, evidently wash, exposed to rain and frost. Below this, red sand for 2½ ft. and boulder clay, the depth of which was not ascertained. It extended down to the bottom of the cup, about 6 ft. of it being exposed. We cut for 2 ft. into its face, but did not reach the chalk, and must consequently suppose it is undisturbed.

On the sand was found a regular floor of chipped pieces, nearly all flakes, sharp and patinated blue, drying to mottled blue and white, corresponding to those found on the sand at the edge of Pits 1 and 2, and also in the sand of section 7. In this case the rubble and blocks were thrown on the top of this floor and sand. It explains also how sand could fall over the side of the pit without getting mixed with the chalk and rubble, as the latter was added later.

Section 11. (Beaver Pit.)

This section was cut by Dr. Allinson in the centre of the pit immediately W. of Floor 3, in order to see if any implements had found their way into the centre of the cup. It proved very rich in bones, amongst them part of the skull, jaws and teeth, and part of the skeleton of a beaver, 2½ ft. below the surface. This is the first recorded example found in the county of Norfolk. The absence of water at the Graves makes it unlikely that the animal travelled here in search of food. At the present time the nearest river is the Ouse, one mile distant. Possibly, however, a stream might have run close to the Brandon road along the valley which commences near the Graves plantation, and in such a case the beaver's presence might be explained. Or it may have been killed elsewhere and brought thither for food, or for the sake of its skin. Whilst the beaver is recorded in Cave times, it was fairly common in England as late as the Saxon period, this being testified by many place-names, such as Beverley. The rest of the bones, mainly sheep and ox, were in the centre of the cup, in a definite layer, not deeper than 2½ ft., beneath which commenced a layer of fine chalk-rubble, similar to layer 2 in Pit 2. Amongst the bones was a fair number of chipped flints, but these were mainly in the layer of surface material above. From this came an irregular rounded nodule of flint used as a hammer; a fine pointed ovate implement of Drift type, white on both faces with the surfaces much knocked about; and two good choppers. Among the bones, Dr. Allinson found a thick flattened perforated disc of chalk, which was taken at first for a spindle-whorl (described in Mr. Reginald Smith's report), but is apparently a bead. The weight of a necklace of such beads would be considerable. A similar chalk whorl was found in a pit-dwelling at Finkley, near Andover, with pottery, flint implements, articles of bone and wood, and pot-boilers. Several others were

found in a group of nine hut-circles in the valley of the Upper Test, Hants, with implements, mullers, grain-rubbers, hand-made pottery, and bones of red deer, ox, goat, pig, and Celtic short-horn (Stevens' "The Flint Works at Cissbury." Sussex Archæol., Vol. XXIV.). The superficial character of the cup in the Beaver Pit makes it probable that it is later than the Grime's culture. The chipped pieces scattered all over the surface of the Graves are not necessarily of the same date as the chalk bead and the bones.

SECTION 12.

In trying to find the starting point of the mines, we naturally turned to the pit adjoining the tumulus, it being a sort of tradition that this was the earliest pit, and the mound to the S. the material thrown out in digging it. Our section into the tumulus (Section 16), decided upon subsequently, proved this was not entirely correct. The great tumulus pit had a N.N.E.-S.S.W. diameter of 88 ft. and measured 64 ft. S.W.W.-N.E.E. It was thus oval in shape, not circular. The bottom of the hollow lay some 10 ft. below the present surface level, and the edge was not, as in the other pits, raised in the form of an encircling mound. Immediately to the S. was the tumulus, rising from the lip of the pit. Canon Greenwell's evidence of 13 ft. of sand in his pit, adjoining, suggested that a considerable amount of sand had been removed to allow the shaft to be sunk without danger to the workers. A section of the E. margin showed pure sand. Mr. W. G. Clarke supervised a cutting made in the centre of the hollow (Tumulus pit), this cutting measuring 6 ft. by 2½ ft. N.—S. The top-layer was found to be mixed chalk and sand, and in the upper 3 ft. were found portions of red deer antler, molar tooth of horse, long bones of small sheep, vertebra of ox, and bone of dog. Also a flint hammer, and a piece of chalcedonic flint, iron stained and chipped on one side only. The material thrown out was not in layers, and it seemed probable that a previous section had been dug and the site disturbed, possibly in Canon Greenwell's or the Rev. C. H. Manning's time.

SECTION 13. (Fig. 11.)

This was the gangway we cut from Pit 2 to the adjoining pit for the purpose of wheeling the excavated material.

It showed that the shaft was cut through sand and boulder clay, also that some of the chalk was brought to the surface and piled up to form a ring round each pit. This left a V-shaped passage between the pits filled with chalk blocks, the upper part (1 ft. 3 in.) having dark humus between the blocks, and the lower (1 ft. 9 in.) sandy rubble. Boulder clay rises up 9 in. to the W. and 1 ft. 6 in. to the E., and is mixed with chalk in the W. Above this is rubble 1 ft. 9 in. to the W., and blocks 6 in. to the E. It is interesting to note that the blocks have not been shattered by frost. The rounded slopes of the two lips were formed of soft chalk washed down by rain. The V-shaped hollow which contains chalk blocks,

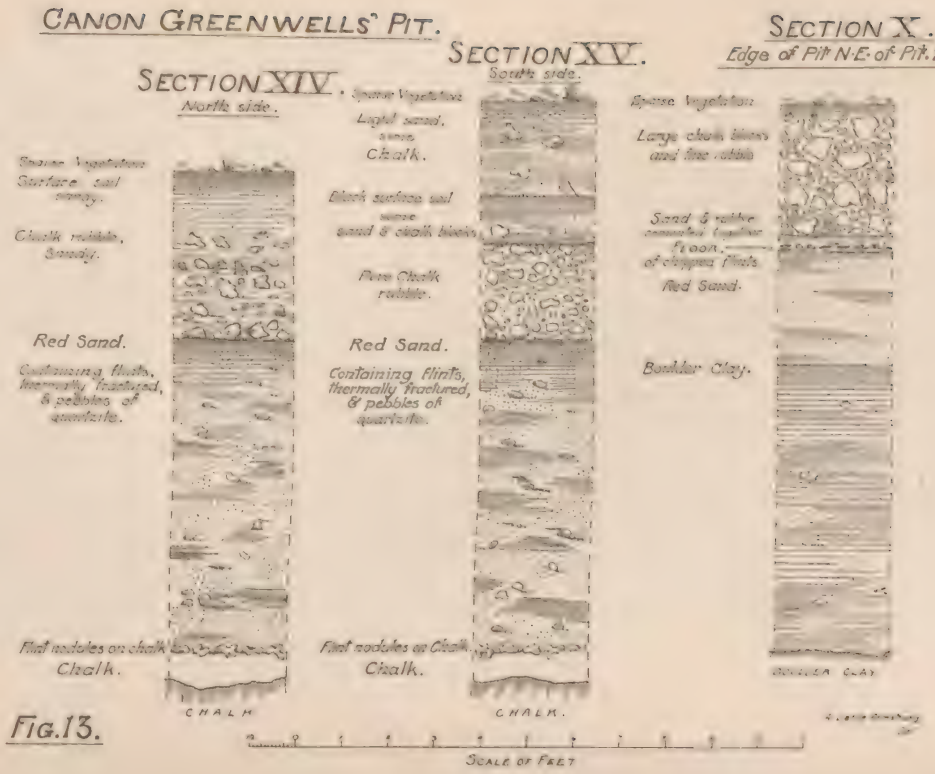

CANON GREENWELLS' PIT.
SECTION XIV.
North side.
Coarse Vegetation
Surface soil
sandy.
Chalk rubble,
Sandy.
Red Sand.
Containing flints,
thermally fractured,
& pebbles of
quartzite.
Flint nodules on chalk
Chalk.
CHALK
SECTION XV.
South side.
Coarse Vegetation
Light sand,
some
Chalk.
Black surface soil
some
sand & chalk blocks
Pure Chalk
rubble.
Red Sand.
Containing Flints,
thermally fractured,
& pebbles of
quartzite.
Flint nodules on Chalk
Chalk.
CHALK.
SECTION X.
Edge of Pit N.E. of Pit 2.
Sparse Vegetation
Large chalk blocks
and fine rubble
Sand & rubble
cemented together
Floor
of chipped Flints
Red Sand.
Boulder Clay.
BOULDER CLAY
SCALE OF FEET

FIG. 13.

with the boulder clay rising up on either side, could hardly have been cut by the miners, and in all probability the boulder clay seen in this section was dumped there from the adjoining pits.

SECTIONS 14—15. (Fig. 13.)

These were cut in the N. and S. lips of Canon Greenwell's pit.

The solid chalk was reached at 10 ft. on the N. side, on the S. side at 11½ ft. In each case a layer of flint was found resting on the chalk as in Pits 1 and 2, and section 9. The amount of sand on each side was uniform, viz., 6½ ft., with 3½ ft. of chalky rubble mixed with much sand on the N. side, and 2 ft. of pure rubble on the S. On this S. side, in addition, above the rubble was a layer of dark sand 1 ft. thick, with some chalk blocks in it, above which were 2 ft. of light sand, mixed to some extent with chalk. As far as it is possible to read these sections, the dark sandy surface represents the top of the mound in Canon Greenwell's time, and the 2 ft. above is the material thrown out by him and accumulated since. The sand contained quantities of small quartzite pebbles, which were practically absent from any other part where we cut into sand and boulder clay. Very few flakes came to light, and only part of an antler and horn-core of red deer (N. side). In the undisturbed rubble of the east lip I obtained a tooth of ox, and Professor P. F. Kendall, F.G.S., of Leeds, found an astragalus of red deer.

SECTION 17.

On April 8th Mr. Reginald Smith and Mr. J. Reid Moir made a section in the wood 200 yards from the tumulus, and found 1 ft. of sandy surface soil, containing black lustrous flints, unpatinated, with some blue and white, cherty, and lustrous. They were mostly small, and neither of the Grime's culture, nor resembling the surface pieces from the Graves. Beneath the sand was boulder clay.

SECTION 18.

Subsequently Dr. Allinson dug a series of shallow holes E. of the tumulus, and obtained the same results as above. Clearly this part is outside the Grime's Graves culture, and emphasises how extremely local that culture is.

ON THE PATINATION OF THE CHIPPED PIECES FOUND DURING THE EXCAVATIONS.

It is, I think, permissible to say a few words on the changes noticed in the surface of the chipped pieces (as attention was particularly drawn to this in the present investigation), without in any way encroaching on the subject of the implements which are dealt with by Mr. Reginald Smith, F.S.A., in the special report.

Various remarks have already been made about the patination of the flints, especially in the section dealing with floor 3, where it was observed that the agent causing the change must have acted from above. It is quite certain that this agent did not act chemically on the chalk rubble below floor 3C and produce a gas, otherwise the flints nearest the chalk would have shown the greatest change, and the under face would have been more heavily patinated, but the converse was the case. It should be noted that in a shallow floor of this kind rain would freely percolate between the flints and reach the chalk rubble below.

It is evident that it is not necessary for a flint to remain exposed to direct sunlight for its surface to undergo a change. If this were so we must suppose that all the blue pieces were left on the surface for a certain period, and the white pieces for a longer period, as the change is greater in these. Moreover as many of the white pieces are patinated blue on the under face it would be necessary for all of these to be turned over to acquire that colour, and it is obvious that this floor was in just the same condition as when left by the miners.

The sequence of patinas in each shaft was the same. In layer 1, where the pieces were exposed for some time until rainwash gradually buried them, the change was thick on both faces, making the flint a dead white, this being to a fair extent destroyed, as if the softened surface had been knocked about. In layer 2 the white patina was not so decided, and the flakes showed a difference on the two sides, that beneath being less patinated.

In the sandy edge, the degree varied from a deep navy blue, not turning white, to a blue that whitened as the surface became dry. Others were a mottled bluish white, becoming lighter. The same thing was seen in the chipped pieces from the surface of the ground when the mining took place, in floor 3A and sections 7 and 13. Where sand was the matrix it is evident the pieces would not long remain exposed to sunlight.

In layer 3, where it formed part of the encircling mound, some of the pieces were dead white on both faces, but blue where they were buried deeper and situated between the blocks. In layer 4 some were dead white, but most were blue—the former pointing to proximity to the surface for a long period. In layer 5 there were no dead whites, but some of the blues turned white when dry, whilst other pieces were black, turning a faint blue, or remaining unchanged. In layer 7 a ball hammer was dead black and a nosed piece bluish.

In layer 8, at 26–29 ft. S., some of the pieces were a mottled blue white, but most were entirely unchanged, as was the flint in the galleries. The flints found in the sand in the latter have been referred to. The pieces scattered so profusely over the surface of the Graves and the fields to the N. and N.W. are invariably white, many with the hidden face blue, turning white. These facts point to two agencies—(1) derived from the sun's rays, and including the influence of heat; (2) a chemical one, brought down by the rain. Another factor will be mentioned later.

Iron-staining on the chipped flints scattered over the surface of the plantation is conspicuous by its absence. The same thing is seen when the quantities of chipped pieces from the two shafts and floors and sections are examined. Of the thousands of chipped pieces collected from the above I could find only three pieces with iron-moulding. Mr. W. G. Clarke mentions in "Proceedings P. Soc., E.A.," Vol. I., p. 437, that he found an iron-moulded chipped flint in the undisturbed lip of one of the pits. One of the three pieces was a flake from floor 13 which lay just below the surface; another, a blue flake, came from a depth of 1½ ft. from layer 1, pit 2, the iron stains being on the surface and the arêtes. The third piece was a ball-shaped hammer which came from the tumulus section 3 ft. below the surface. If any general agent were at work producing iron-moulding, it is difficult to see why only four pieces should be affected and no others.

It is instructive to study the pieces from the field to the west of the plantation in connection with the subject of patina and iron-moulding. The part of the field near the Graves contains, as section 3 proved, a number of pits which have been smoothed over and the surface ploughed for a considerable period. This area is literally covered with chipped pieces similar to those in the plantation, as Mr. J. S. Warburton has shown in his paper (Proceedings, P. Soc., E.A., Vol. I., p. 420). In a general way, those nearest the plantation are a dull white, whilst further down the slope the white surface is lustrous, apparently from the passage of fine sand which is continually blown across the field. All, however, show a high percentage of iron stains. Further down the hill the chipped pieces are mostly blue, or a lustrous black, with a few Grime's Graves pieces mixed with them. At the bottom of the valley the Grime's pieces entirely disappear and only black pieces are to be found, whilst on the opposite slope the black pieces persist and arrowheads are not uncommon. (These facts were pointed out to me by Mr. E. T. Lingwood, and I was able fully to corroborate them.)

Beyond a large area planted with broom another zone of Grime's Graves' pieces is seen. These are either white, or deep blue or black; but the black pieces are of the Grime's type, although not like those previously mentioned. With the former are quantities of pieces patinated in a chalcedonic manner. The latter are not a true chalcedonic variety of flint but black with a surface change, as is easily demonstrated when one is fractured. The same

chalcedonic patina predominates to the S. of the plantation in Santon parish, but the finer black pieces are also found there and many pieces are scratched. Moreover the white pieces so profusely scattered over the Graves are practically absent as soon as the margin of the plantation is crossed. The whole of this S. area seems to be one vast workshop. The proximity of the mines suggests that the flint scattered on this surface came from the Graves. It seems incredible that the miners should observe such a sharp line of demarcation unless the mines are no older than the bank which still forms the parish boundary on the S. side of the plantation. It is far more probable that the flint found in the field on the S. side of the Graves came from the mines as Canon Greenwell suggested, and that (1) either the chipped pieces represent a later period, or (2) the sandy soil in which the pieces lie has in it some ingredient which has caused the flint to assume a different surface change. The flint used over this area is a pure one, and seems undoubtedly to have come from the floor level of the mines; corroboration of this area being very largely the workshop in which the mine product was worked up into implements is seen in the similarity of numbers of implements obtained from this spot to those from the Graves. In the extensive collections obtained from this area by Dr. Allen Sturge, Miss N. Layard, Mr. W. G. Clarke, and Mr. H. H. Halls, are many pieces which resemble both in form and in character of the work those from the Graves. The floor found beneath the tumulus, somewhat older than the interment, shows that when flints are deeply buried the patinating agent cannot act upon them. These pieces showed numerous quicksilver-like specks on the surface of the flint which is generally considered indicative of great antiquity.

In the account of floor 3 it is shown that the white pieces are no older, and possibly not so old as the blue and the black pieces below, and the evidence of the shafts shows that the pits were not cut through a surface strewn with implements of older date. The pieces from the top of the sand (recognised as the surface when the mining took place) are also not found in the bottom of the shafts, and only occur in the sand tilted in and forming the lining of the sides of the pits. They differ only in colour from the mass of material in floor 3c. From this evidence it would seem to be unreliable to date pieces from the surface (from this area) by the degree of change which their surface has undergone. If a floor like floor 3 had been ploughed up on the surface (as appears to have been done in the field a mile west of the Graves) and the pieces mixed up together, erroneous conclusions would be drawn if in picking out the white, blue, and black pieces, and those with two-sided patination, we assigned them to different periods, as the evidence of the floor shows that they are all contemporary. The lesson from Spiennes is very similar, as is mentioned on p. 22. The third factor referred to above is the varying composition of the flint, and consequently the hardness or softness of the surface, which is a potent factor in influencing the change which various

agents can effect in its composition. M. Rutot has recorded that the implements and workshop refuse made from the black Obourg flint lying on the surface, have not acquired any change, that industry being placed before that of Spiennes, where the grey flint is unchanged in the galleries, but is patinated white and iron-moulded when left on the surface. The question of patina is a very complicated subject, and the remarks made here are drawn mainly from the present investigations. To gain some idea of the varieties into which patinated pieces fall, and of how large is the scope of such an enquiry, it is only necessary to see the numbers of classes into which Dr. Allen Sturge has been able to separate them. The ingredients of the matrix in which a flint has lain have been mentioned as a possible factor in influencing the change of its surface, and it is possible that in previous ages there were others of which we now have no knowledge.

One of the most surprising facts at Grime's Graves is that scarcely a single piece is rechipped. The surface ever since the mining ceased has been strewn with implements in all stages of manufacture, but it is difficult to find a single piece adapted by a later race for use, and this is all the more surprising as rechipping is common in most of the flint work assigned to the Neolithic Age.

Also connected with the subject of patina and the quality of flint used is the curious absence of any flint work from the surface of the plantation which can be assigned to a different period. On the surface, in most districts, notably at Hambleden, S. Bucks, one finds a variety of implements which differ in shape and in the character of the work, seeming to be an epitome of the life history of that district, but on the surface of the Graves, no flint work except that which can easily be assigned to the one culture, is to be found. This is not, of course, an isolated case, but it is none the less remarkable.

THE IMPLEMENTS USED IN THE MINE: WITH REFERENCE TO THE USE OF A POLISHED AXE.

Mention has been made in the preceding pages of various marks in the galleries, including those caused by a smooth implement, and it is useful to review the evidence on this head because it has an important bearing upon the question of date.

As has been shown, some of these marks, and also others upon detached chalk blocks, establish the deer-horn pick as the main implement used in mining, the recovery of quantities of these picks from the shafts and galleries affording ample corroboration of such evidence. Some of the marks indicate the use of the pick alone to loosen the chalk and flint, and by their striation many show that even after the sharp tips were broken off the horns were still serviceable to some extent. The hammered condition of the heads of so many of the deer-horn picks suggests a method of splitting the chalk in its line of fissure by means of wedges, detached tines, or first-year horns, or even sharp broad flakes. Possibly, too, one

horn may have been held with its tine against the chalk, while another was used to hammer it, and some of the straight-tined horns could have been used in this way. The majority, however, have the brow-tine curved in one direction, and a blow on the head of such a pick would not be very effective.

Another form of hammer used was the natural T-headed nodule found in gallery 8. Flint spicules embedded in the head of a pick show that the hammered condition of so many of them is caused in splitting the flint nodules. The miners at Mur-de-Barrez, as will be seen from the short account of that site, improved on the natural pick. That a chipped flint axe was probably used also, is indicated by marks in Pit 2, and by about twenty marks in gallery 12, Pit 1, the description of the latter being given fully under the heading of Gallery 12. They correspond in breadth with the broad end of the axe (Fig. 26) found in the black band; the striation of their surface showing that the axe was chipped and not ground. A chipped axe was found in Pit 1, and another has since come to light from Pit 2.

The pointed marks in a chalk block referred to previously also evidence the use of this axe, which, with a haft, would be a most effective implement for such work.

It might be objected that as this axe was found in the black band when Pit 1 was more than half filled, it could not have been used in the galleries, to which access was thus cut off in the shaft. But as I have shown elsewhere, gallery 12 belonged to the system of shaft 5, which was apparently open somewhat later than Pit 1, and the black band level might well have served as a dwelling-place for the miners who were working in the adjacent shaft. No marks corresponding to the implement (Fig. 24) were found, though this, too, with a haft would have been an efficient tool for excavation. With regard to the marks of a smooth-faced implement, these were found in both the shafts that were excavated, occurring as follows:—

Pit 1, Gallery 1.—On the right of the creep-hole leading to gallery 2, one good mark. This measured $\frac{2}{3}$ in. in diameter and $1\frac{1}{4}$ in. in length. A cast of the mark showed that the cutting edge was not straight, but curved, a feature noticeable in many of the polished axes in Dr. Sturge's collection. The mark left on the chalk was not sharp, but blunt at the end. It was found after the gallery had been cleared of chalk, which had hidden it.

There were also in this gallery glancing blows; but as Lieut. Hall was using an ice-axe, and the men were using shovels, I am not convinced of the origin of these.

Gallery 2.—Two good marks were found in the apse of this gallery, and several glancing blows. They were also found after the gallery had been cleared. One of them measured $1\frac{3}{4}$ in. long and $\frac{7}{12}$ in. across. These were not sharp at the end.

From the position of these marks, high up in the domed roof of the apse, the implement must have been used either with a short handle, or none at all.

Gallery 7.—The best marks were found in the walls of the apse leading to gallery 6. Of these, one of the largest was found on the left, and nine others on the right wall. Measurements and casts of three were taken—(1) A large mark 3½ in. broad, 1½ in. diameter, taken at ¾ in. from the end. The cast of this mark shows that the edge was not straight, but in the form of an ogee curve, sharp at the end. (2) A mark ¾ in. broad, 1 in. in diameter, taken ¾ in. from the end, which in this mark is blunt. (3) A mark 2½ in. broad, ¾ in. diameter, taken ½ in. from the end.

Gallery 6.—One smooth mark, triangular in section, was found on the wall of the apse beneath undisturbed blocks of chalk.

Gallery 15.—This, which was at first thought to be a new gallery, proved to be the base of the shaft, No. 2. Lieut. W. Hall who was clearing this part with an ice-axe, first noticed the marks. They were smaller than those noticed subsequently in gallery 7 (see above), but the section showed they had been caused by an implement with two convex smooth faces.

Gallery 13.—One mark was found when chalk blocks were removed, on the left side beyond the apse.

Pit 2, Gallery 5.—Here were noticed four marks of end-blows from a smooth implement. Three of these were on the roof of the apse, on the left side, and one on the right. In addition to these were a number of glancing blows on the roof. Mr. Casey first penetrated to the end of this gallery, and pointed out to me some of these marks. Besides the smooth marks there was one different from the rest, a concave mark with scratches on the face, which again suggests the occasional use of a chipped axe in the galleries. This mark occurred near the creep-hole at the beginning of the apse.

Gallery 11.—There was here a group of three marks close together, of V-shaped section; also a series of glancing blows, first noticed by Mr. Casey, on the buttress between galleries 2 and 3. In neither of the two galleries in Pit 2 where smooth axe marks were discovered, was any excavating implement found, except red deer horn picks.

As no smooth axe was found in the galleries and shafts, amongst some hundreds of flint implements, a certain amount of doubt must exist on the question whether a polished axe was used or not. In Pit 2 there seems no reasonable cause to doubt the use of such an implement in galleries 5 and 11, but to a surprisingly small extent if one reflects upon the efficiency of such an implement compared with the deer-horn pick. A very careful examination of the other galleries of this pit, and notably the open apses of galleries 7, 8, 4, and 2 entirely failed to reveal any similar marks. This was not due to falls of the roof or sides, for the apses in question were profusely studded with deer-horn pick marks.

In Pit 1 no marks came to light until Lieutenant W. Hall uncovered the first ones in the shaft-base, gallery 15. At that time numbers of visitors had been through the other galleries.

It is perfectly certain that the deep marks in Pit 1, galleries

7, 2, and 1, were not caused either by the ice-axe or shovels used in clearing out the rubble, while it is fairly clear that more than one size of smooth implement had been used. It has been suggested that a suitably-shaped flake might cause some of these marks, and in the case of the glancing blows, this may well be so.

The only implement of axe form found in the base of either pit was one* (Fig. 29) which Mr. Holden found on the floor of the shaft (Pit 1) amongst the rubble and blocks after the work was finished. The shaft-floor had been cleared several times from the material thrown out of the galleries, and this mass of chalk came from the common entrance to galleries 10, 11, and 8. The broad end of this axe is chipped and rough, and could not on that account have made the smooth marks.

The smooth axe-marks were never found just above the floor-flint, this space being always studded with the deer-horn pick marks, possibly because that implement could be used more effectively in that position. The smooth axe-marks all occurred in the sloping roofs of the apses, well above the floor-flint line. We could only be certain of those marks of a smooth implement which showed the impression in the chalk of the sharp end of the axe. The glancing blows might have been made equally well either by the shovel or ice-axe, and a good many of those noticed in galleries 1, 7, and 11 were so caused. The list I have given enumerates the total of these marks, noticed by myself, or pointed out to me by others. One cannot help being struck by the fact that, with the exception of gallery 7, the marks in each gallery are extraordinarily few. Thus, in gallery 1, there was only a single end-blow from a smooth axe; in gallery 2, two only; in galleries 6 and 13 one each. One would have thought that if a smooth axe was being used at all, it would be employed as freely, or even more so, than a deer-horn pick, it being certainly a far more useful implement, especially in driving the main galleries; and in that case one would expect to find as many marks of the smooth axe as of the deer-horn picks. The latter were seen everywhere in great numbers. In order to see if any more marks of this kind could be detected, I afterwards devoted an afternoon to turning over the blocks all along one side of gallery 13 (Pit 1), and could not find another mark of this kind, which makes a single mark all the more extraordinary.

We cleared out galleries 1 and 2 completely, and yet only three axe-marks were found in the two galleries. These facts are certainly remarkable, and seem to call for a good deal of explanation. It may seem strange that no smooth axe marks were noticed when the galleries were first entered especially as, bearing in mind the axe found in Canon Greenwell's pit, we were on the *qui vive* for marks of any sort. The wall and roof were examined with an acetylene lamp when the galleries were entered for the first time, and if any marks existed they would certainly have been seen in this bright light. A large number of the marks were hidden by

* Another from Pit 2 is now recorded.

chalk rubble and blocks. The freshness of the old marks in the chalk, which in no wise differed from the new ones caused by the curved shovels and coal-shovel used by the men in Pit 1, made the identification of the former a more difficult matter. The axe marks were identified by Mr. W. G. Clarke, Mr. Dixon Hewitt, Mr. A. Gilligan, F.G.S., Professor P. F. Kendall, F.G.S., and others, who were quite satisfied they were authentic, and I personally have no doubt they were caused by a smooth axe. It is interesting to note in this connection that Lieutenant-Colonel B. C. P. Hamilton, of Brandon, has a polished axe found by the Rev. Powley, marked "Grime's Graves." It is, however, a surface piece, and is not necessarily of the same date as the mines.

CONCLUSION.

It will be realised from the foregoing report that much yet remains to be learnt about this great period. Although a great deal of light has been thrown on many points, a good deal is still obscure. We have seen from other mining sites that the sought-for seam of flint was first found cropping out on the surface, but where that was—that is at which spot the mining at Grime's Graves started, is still a mystery. It is possible the miners commenced either in the centre and spread in all directions, or at the end of the plantation, or in the field to the west or north; but on this point we have thrown no light. It is even likely the knowledge was acquired elsewhere.

The question of the boulder clay spread across the first pit requires further elucidation, as it was not supported by the facts of the second pit.

The fauna of the period is still very meagre, and it is doubtful if many of the bones can be included in the period of the industry, as most of them were close to the surface. No light whatever was thrown on the religious customs of the times, but the finding of various pieces of carved chalk suggests that something may yet be learned in the investigation of other pits.

The plan of the Graves shows a group of small pits, about 100 in number, on the S.W. side of the plantations. A few, much smaller than the rest, are marked elsewhere, but as these are merely slight dimples on the surface it is impossible to estimate the size of the shafts. The former may belong to a different date, possibly much later than the rest. The question of polishing requires more light on it. The paucity of polished axe marks in some of the galleries in which they occurred is rather difficult of explanation. The flora and mollusca from the galleries and lower parts of the shafts are also scanty, and it is quite possible that another pit may have material better preserved. The means of access to the mine and the methods of working it may yet be found out. It is much to be hoped that further work will be carried on. The yield from the two pits and the few floors excavated is very large, but comparatively slight to what must yet

remain buried, when we remember there are quite 346 pits in this wonderful area. The few objects which came from the galleries furnish valuable evidence, and systematic work in this direction should yield much additional information.

My cordial thanks are due to all who voluntarily assisted in the work, which proceeded harmoniously from first to last. I am specially indebted to Mr. A. Leslie Armstrong, F.S.A., Scot., who rendered valuable assistance in exploring and mapping the galleries and in making a plan of the whole area of the Graves; to Mr. E. T. Lingwood for drawing the sections and relieving me of a great deal of the harder work; to Dr. B. Allinson, who was indefatigable in digging over the "floors"; to Lieut. W. Hall and Mr. D. Casey, who took an active part in exploring and clearing out the galleries; to Mrs. Lingwood, who, in spite of the inclement weather, undertook much of the packing of specimens; to the Hon. Secretary, Mr. W. G. Clarke, for carrying out the many arrangements connected with the work, and to Mr. J. Reid Moir, F.R.A.I., Mr. Reg. A. Smith, B.A., F.S.A., Mr. A. Mayfield, M.C.S., Mr. E. St. Hilary Lingwood, and the Rev. A. Cross, who contributed help in various ways.

The Human Remains.

By Prof. Arthur Keith, F.R.S., F.R.C.S., LL.D., M.D.

Remains were found of two individuals:

(1). The calvaria of a man's skull (*See* Figs. 14, 15, 16). As the sutures are open on both the outer and inner aspects, I infer that the skull belonged to a man under thirty years of age. The calvaria was found in Pit 1, at a depth of 10 ft. 8 in. below the cut edge (*i.e.*, 14 ft. 10 in. below the standard level taken horizontally across the highest point of the mound encircling the pit), on March 11th, 1914. It lay 18 ins. below the black band. No other part of this individual was found; there was apparently no deliberate interment of a complete body at the site occupied by the calvaria in Pit 1.

(2). Parts of the skeleton of a child—probably a girl—aged about 13, of a particularly slender conformation of body. All the permanent teeth of the mandible are in position except the last or third molars, but had only recently come into use, for the canine premolar and second molar teeth show only the slightest degree of wear. The parts found of this individual are (*a*) the "body" or tooth-bearing part of the lower jaw (*See* Fig. 17); (*b*) the shafts of the right and left thigh-bones, the epiphyses being missing and small parts broken away from the upper extremities; (*c*) the shafts of the right and left tibiæ, the epiphyses or end-pieces being lost;

(*d*) three-fourths of the shaft of the right fibula; (*e*) the metatarsal bones of the great and second toes of the left foot. Of the upper extremities: (*f*) the greater parts of the right and left collar-bones; (*g*) the shafts of the right and left humeri; (*h*) the upper two-thirds of the left ulna and the lower half of the left radius; (*i*) the metacarpal bone of the second finger of the left hand; fragments of vertebræ, ribs and of the base of the skull. There can be no hesitation in assigning all these fragments to the same individual for all are at a corresponding stage of growth, all of a peculiarly slender formation and all were found in the same part of pit No. 2. The mandible was found at a depth of 17 ft. below the top of the surrounding mound, 10 ft. below the cut surface of pit. The limb bones were found at various levels above the lower jaw, and other parts of the skeleton below the jaw. It is difficult to suppose that mere subsidence or earth movements could have separated the various parts of this skeleton and given them the dislocated distribution observed by Dr. Peake. The disposition of parts can be best explained by supposing that the original interment had been disturbed during the filling in of the pit.

CALVARIA FROM PIT 1, FOUND AT A DEPTH OF 10-FT. 8-IN.

The accurate drawings shown in Figs. 14, 15, 16, make an elaborate description unnecessary. All the basal parts of the skull are missing; so is a considerable part of the forehead. Enough is preserved to permit us to form an accurate estimate of the dimensions of the head and of its racial characters. The skull, as represented in Figs. 14, 15, 16, has been orientated on a horizontal plane which passes through the fronto-molar junction anteriorly and the lower hinder angle of the parietal bone behind—these points being usually preserved in fragmentary ancient crania, and therefore suitable to serve as guides in comparing ancient and modern crania. The maximum length of the skull may be estimated to have been (the glabella is broken away) about 192 mm.; the maximum width, 145 mm.; the width represents 75·5 % of the length. The individual therefore exhibited a moderate degree of dolichocephaly. The vault of the skull rises 102 mm. above the base line of orientation; the elevation of the vault in English male skulls, possessing a brain of average size, is 100 mm. In height of vault this ancient skull is slightly above the modern average. The auricular height was probably about 117 mm.—for the auditory meatus lies usually about 15 mm. below the line here employed as a base line. Using the Lee-Pearson formula (L. 192 × W 145, × A.H. 117 × 000337 + 406) we obtain for this skull a brain capacity of 1532 cc.—being about 50 cc. above the mean capacity for modern Englishmen. As regards thickness, the bones of this skull measure more than is usual amongst modern Englishmen. The parietal bone along the vault has a thickness of 8 mm.; the upper part of the frontal bone is only 5 mm. thick. As will be seen from Fig. 14 the occipital bone attains a thickness of 18 mm. in the region of the inion—the latter point being particularly prominent but situated well below the

level of the internal inion (*See* Fig. 14). The supra-orbitral region is broken away except on the left side (Fig. 15), but enough is present to show that the supra-orbital ridges were pronounced and shaped as in robust skulls of the modern type. The frontal air sinus was not extensive; in an upward direction it merely reached the depression above the glabellar eminence. The forehead is wide: the minimum width, measured between the temporal lines (*See* Fig. 15) is 100 mm. The width of the forehead in the supra-orbital region, measured between the extremities of the external angular processes is 110 mm. There is thus a difference of 10 mm. between the supra-orbital width and minimum frontal width—a degree of difference found in male skulls where the muscular impressions and processes are well developed.

How this specimen stands to skulls of modern Englishmen is emphasised in Figs. 14, 15, 16. The framework of lines in which these drawings are set represents the average dimensions of modern English male skulls. The maximum length of an average skull is

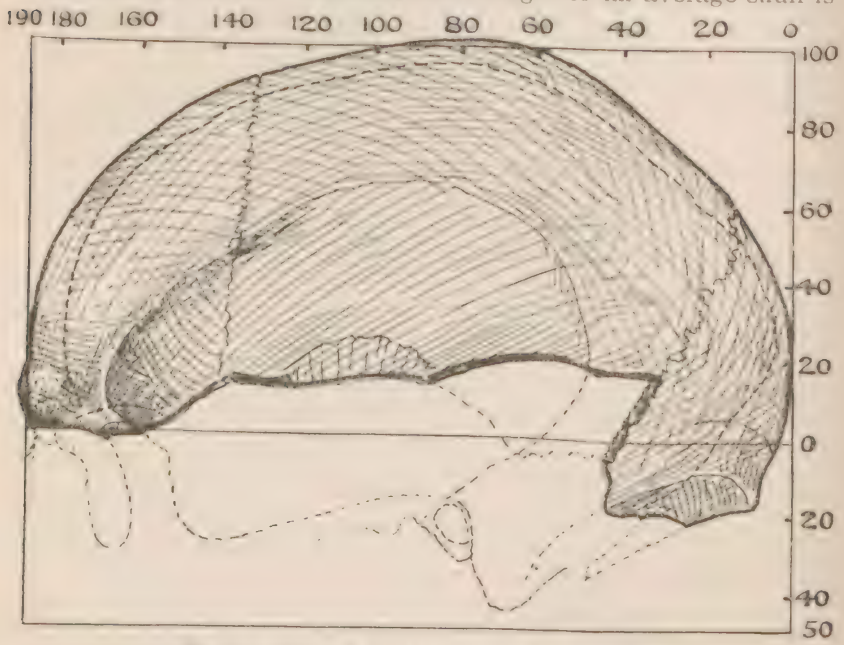


Fig. 14. Grime's Graves calvaria in profile.

190 mm. The Grime's Graves skull is slightly longer and considerably wider, for it will be seen that the average width is represented as 140 mm.; in this specimen it is 145 mm. The height of the vault is slightly above the modern mean, and, as already pointed out, the brain capacity is above the modern average. So far as actual conformation is concerned there is no feature which differentiates the specimen found at Grime's Graves (Pit No. 1) from a still prevalent English type. The skull thus found at Grime's

Graves has a very close resemblance to the two found during the excavations at Cissbury. The Cissbury skulls and skeletons have been described by Professor Rolleston (Journ. of Anthrop. Inst. 1876, vol. 6, p. 20, 1878, vol. 8, p. 377). The Cissbury skulls are now preserved in the University Museum, Oxford. One is that of a man; the other of a woman. The condition of preservation is exactly the same in the Grime's Graves calvaria as in the two Cissbury skulls. All are of that peculiar grey colour and white chalky texture which characterise ancient skulls which have been preserved in a chalky soil.

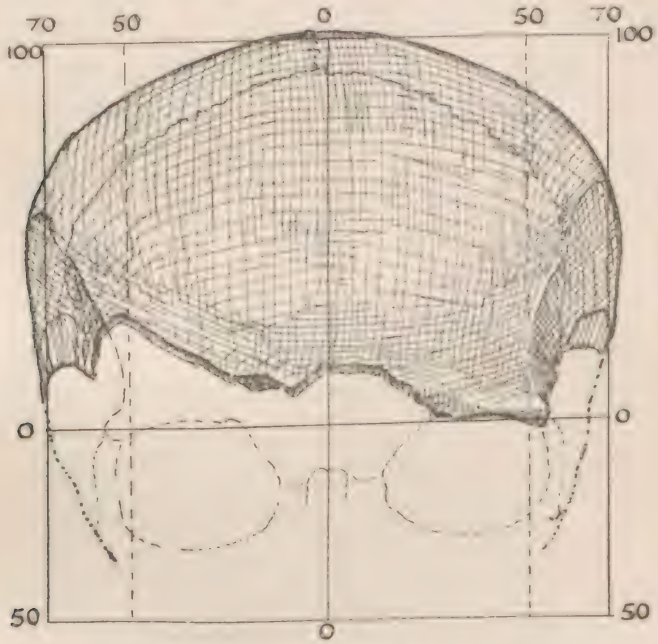


Fig. 15. Grime's Graves calvaria from the front.

In form, type and physical characters the Grime's Graves specimen agrees with those from Cissbury. One may infer with certainty that they belong to the same race. The woman's skull from Cissbury is remarkable for its brain capacity. Rolleston's estimate of the capacity is 1732 cc., which is more than one would expect from the dimensions of the skull. These are given by Rolleston as:—length 195 mm.; width 144 mm.; cephalic index 74%. The male Cissbury skull, like that from Grime's Graves, has the sutures open, Rolleston estimating the age of the individual as under 50 years. The dimensions, however, are less than in the Grime's Graves skull—maximum length 184 mm.; maximum width 132 mm. and cephalic index 71 %—a narrow small skull. The brain capacity is estimated to be 1380 cc.

The antiquity of the human remains from Cissbury, as from Grime's Graves, rests on archæological evidence. So far as the cranial characters are concerned, they may be assigned to either a late Paleolithic period, or to the Neolithic, or even a later time. The skull from the Cheddar cave, regarded as of Magdalenian date,

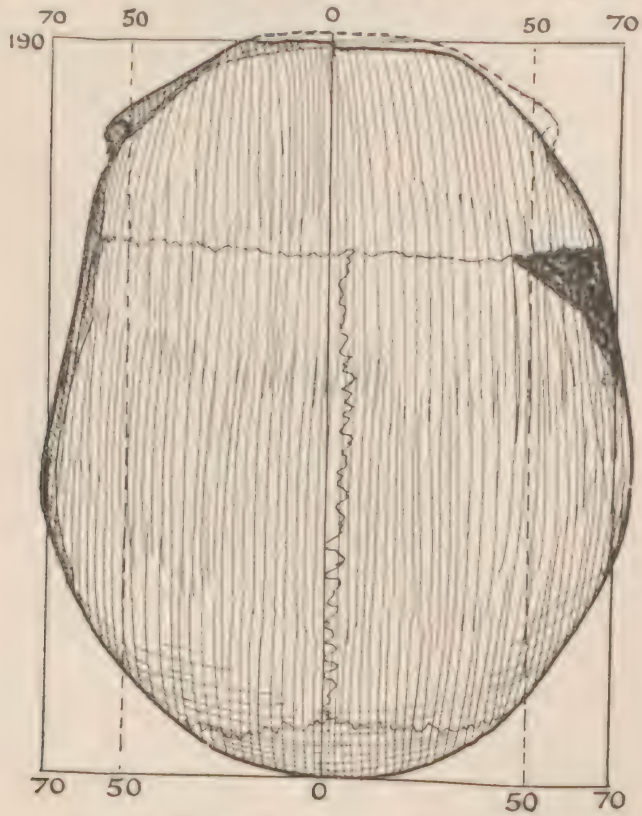


Fig. 16. Grime's Graves calvaria from above.

and two others from a cave in the Mendips of the same Paleolithic period as the Cheddar specimen, which were recently shown to me by Prof. Fawcett, are of the same type as the Cissbury and Grime's Graves crania. Many of the skulls from barrows of the Neolithic period are also of a similar type. As regards its shape, the Grime's Graves calvaria is just as likely to be late Paleolithic as Neolithic.

THE GIRL'S SKELETON FROM PIT 2. (Plate XVI., top.)

As only small fragments of the skull were found, we can make no statement regarding the form of head. An exact drawing of the mandibular fragment in profile is represented in Fig. 17. The rami were missing; only the body with the teeth were preserved. The fragment is represented in Fig. 17 superimposed on the mandible of

a boy aged 12 years—the various teeth being made to correspond. The outstanding feature of this mandible is its shallowness. The lower border of the boy's jaw falls fully 5 mm. below that of the specimen under examination. In the mandible of this ancient girl the symphysis has a vertical depth of 20 mm.; its antero-posterior diameter is 13 mm. The corresponding dimensions in the boy's mandible are 25 mm. and 13·5 mm. Although shallow the girl's mandible is thick; for instance, at the level of the second molar tooth, the depth or vertical measurement of the mandible is 14 mm.; its thickness or transverse diameter 13·5 mm.

As already said, all the permanent teeth are in position except the last molars. The canine, premolar and second molar teeth had come into use a very short time before death, for they were scarcely worn. The incisor teeth have very shallow sockets and incline forwards—are proclivous. The teeth show no peculiar features either

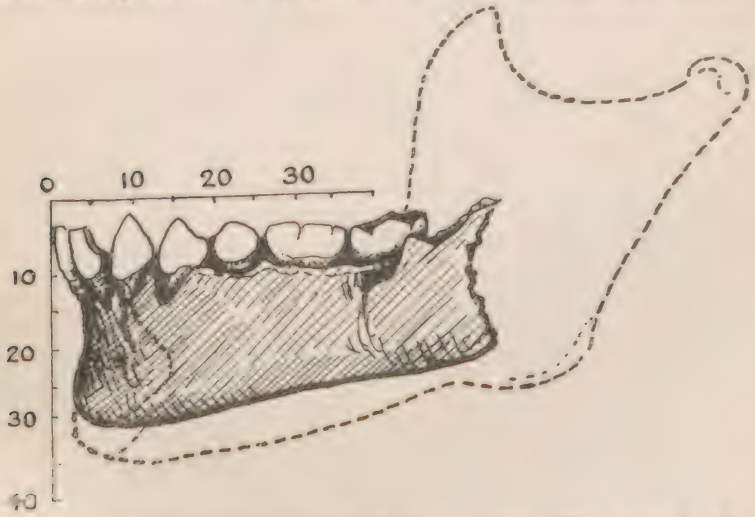


Fig. 17. Grime's Graves mandible (Pit 2) in profile. The stippled outline represents the mandible of an English lad, aged 12 years.

as regards size, shape, or development of cusps. The outer cusp of the first premolar is unusually sharp and prominent. The fifth cusp is plainly to be seen in the first molars, but is scarcely distinguishable on the second. The width between the outer border of the second molar teeth is 59 mm.: between the outer borders of the two canine, 29 mm. Both of these measurements indicate a rather narrow jaw. The dimensions of the first molar exceed those of the second. The antero-posterior diameter of the first molar is 10 mm., its width 10 mm.; in the case of the second, the corresponding measurements are 9·5 mm., 8·5 mm. The mandible, although particularly shallow, is of a type frequently seen in a modern English population. I was surprised when I began to make observations on the matter, how often one saw amongst young

women and girls the same shallow mandible and proclivous incisor teeth as I noted in the Grime's Graves mandible.

The shafts of all the long bones are particularly slender. To illustrate this feature I have represented, in Fig. 18, a section across the middle of the shaft of the tibia and across the inner or sternal

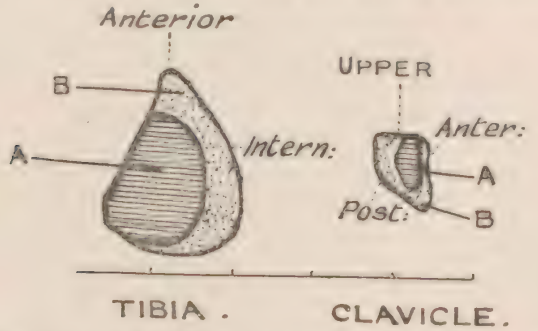


Fig. 18. Sections across the tibia at the middle of the shaft and clavicle at its inner end: A. of the Grime's Graves girl; B. of a boy aged 12 years.

end of the clavicle. The sections are shaded and set within corresponding sections taken from the skeleton of a modern boy aged 12 years—the skeleton I have used as a standard for comparison. While the tibia of the girl at its middle point had an antero-posterior diameter of 17 mm. and a transverse one of 12 mm., the same measurements of the boy's tibia were 24 mm. by 16·5 mm. At the level of the nutrient foramen these measurements in the girl's tibia were 20 mm. by 15 mm.; in the boy's 27 mm. by 21 mm. The shaft of the girl's tibia is rounded; there are no sharp margins between its various surfaces, the anterior crest or shin being absent. The backward curvature of the shaft of the tibia is greater than in modern bones, but the measurements show that there is only a slight degree of lateral compression of the shaft. The diameters of the shaft of the left tibia slightly exceed those of the right bone.

As regards the femora, the linea aspera is only slightly developed: the shafts are slender and rather more curved than are the thigh bones of modern children. There is a distinct degree of back-to-front flattening in the upper third of the femur, the diameters being 19·5 mm. (transverse), 16 mm. (antero-posterior). The corresponding measurements in the boy's thigh-bone are 28 mm. by 23·5 mm. The upper third of the girl's femur is flattened, as already mentioned. Along its external (not posterior) aspect is a rough vertical furrow marking the insertion of the gluteus maximus.

The clavicles have well marked curvatures and are of a particularly slender build. The inner or sternal extremities are flattened from before backwards (*See* Fig. 18). The following measurements of the sternal end show how far the girl's clavicle falls short of that of a modern boy. In the boy the vertical diameter at the sternal end is 10 mm.; the antero-posterior diameter

9 mm.; the corresponding measurement in the girl is 7 mm. by 5 mm. The length of the clavicle, allowing for a small part which is missing was 92 mm. Its length in the boy 107 mm.

The shaft of the humerus is equally slender. At the middle of the shaft the dorso-ventral diameter is 11·5 mm., its side-to-side diameter 12 mm. The diameters of the right humerus slightly exceed those of the left, showing a preponderance of the right arm, probably due to right-handedness. Only fragments of the left fore-arm bones were found. The upper extremity of the ulna shows a marked degree of curvature—the concavity being situated on the flexor surface. The side-to-side diameter of the shaft is 9 mm.; its front-to-back diameter 8 mm.

An estimate of the stature and proportion of the limbs is complicated by the absence of the growing ends or epiphyses of the long bones. In calculating the original length of the long bones, I have added to the length of the shafts or diaphyses a certain proportion for the missing epiphyses, the proportion being based on the proportion obtaining in the boy's skeleton which I used as a standard. In this way I have estimated that the right thigh bone had a vertical height—its length in the standing posture—of 315 mm.; the right tibia 281 mm. In the boy used as a standard the corresponding measurements were 383 mm. and 300 mm. In the boy the tibia is a little under 80 % of the length of the femur—the usual proportion for a European lad. But in the ancient girl the tibia represents 89 % of the femoral length—a proportion beyond that which holds even for negroid races. Even if I have allowed too much for the missing epiphyses of the tibiæ, my error could not be so great as to account for its abnormal length in comparison with the femoral length. In the skeleton of a youth lately discovered near Ipswich by Mr. Reid Moir and assigned on archæological evidence to a late phase of the Neolithic or early part of the Bronze period, there was a relatively long tibia. In modern Europeans the tibia may represent considerably more than 80 % of the femoral length. In the skeleton of the woman found in the pit at Cissbury, the tibia is just under 80 % of the femoral length; the length of the humerus I estimate to have been 260 mm.

From the length of the bones of the lower limbs the stature of the Grime's Graves girl may be estimated at 3 ft. 11 in. or 4 ft. (1200 mm.). The two skeletons described by Professor Rolleston from Cissbury were of particularly low stature, both the man and woman being under 5 ft. Their limb bones, especially those of the man, were slender. Thus in lowness of stature and in slenderness of build the skeleton of the girl found at Grime's Graves resembles the adult skeletons found at Cissbury.

The remains have been presented to the Museum of the Royal College of Surgeons of England, where they can be seen and examined by those interested.

The Antler-Picks.

By W. G. CLARKE.

So far as this country is concerned, the miners' picks made of red deer antlers appear usually to be associated with implements of "Cissbury type" and presumably with a particular period of culture. They have been found at High Wycombe, Bucks; at Buckenham Tofts, Eaton, Great Massingham and Weeting (Grime's Graves), Norfolk; and at Cissbury, Maumbury Rings, and Stoke Down (Kingley Bottom) near Chichester, Sussex.

An antler-pick with a used brow tine was found in the Roman town of Silchester and is now in Reading Museum. Lord Avebury also states that they were used in the Cornish stream tin workings. One was found at Ipswich, others in loess-like loam near Icklingham, one in a barrow at Rudstone near Bridlington, and others at Weaversthorpe and Sherburn.

They have also been found associated with flint-mines near Malmo in Sweden, at Obourg, Mendon, Strepy, and Spiennes, though at the last-named place they were apparently used as hammers, the horn being cut off just above the brow tine, which served as a handle.

At Grime's Graves, in the two shafts and galleries excavated 244 antler-picks were discovered, and of these it was possible to obtain measurements of 198. On the whole the finest specimen was one I found beneath chalk blocks in gallery 6, Pit 1, in an apse about 8 ft. from the entrance (Plate XXIII.). The length of the beam is 19 in. to which is attached 4 in. of pedicle. The brow tine, with the point broken, is 8½ in. long, and the beam has a circumference of 9 in. immediately above the brow tine. It has not been used as a hammer, nor are there any signs that it was shaped by fire. The distance between bez and trez tines is 8 inches.

As, with one exception, the antlers all have the beam broken off above the trez tine, it is impossible to obtain measurements of complete length. Antlers of prehistoric red deer have been found up to 42½ inches in length, while modern Scotch or English antlers rarely reach 36 in. At Maumbury Rings in 1912 a pair of immense antlers was found attached to part of the skull. One antler measured 3 ft. 2 in. in length, brow tine 14 in., and bez and trez tines 13 in. with a crown of four points.

Though some of the picks found at Grime's Graves were in the galleries of shafts other than those excavated, many were undoubtedly left beneath the chalk blocks with which the galleries were almost filled, and which were only partially removed. It is, therefore, certain that many picks belonging to the shafts excavated were not found, and it is not unfair to assume that the number of picks left by us in the galleries of each shaft was at least 100. As the total number of shafts in the area is not less than 346, such an average for the lot—and Canon Greenwell's shaft and the two

Antler-Pick from Gallery 6, Pit 1.

(Photo by "Prehistoric Society of East Anglia.")

Part of the beam of antler-pick showing finger-prints of miners by whom it was used.
Found in Gallery 4, Pit 2—a partly empty gallery.
(Photo by "Prehistoric Society of East Anglia.")

excavated in 1914 may be considered fairly representative—would give a total of 57,436 discarded antler-picks in Grime's Graves.

Some of these may have belonged to animals living in other districts, and perhaps been received by the miners in exchange for flint, but the presence of numerous bones of red deer indicates that they must have been abundant in the neighbourhood. In historic times, however, up to the middle of the 18th Century, the district in which the Graves are situated was one of the most treeless in the country, and as forests are necessary for the well-being of the red deer, it is probable that its aspect was widely different when the flint-mines were sunk. This is borne out by the charcoal and mollusca found in the shafts, and by the presence of the beaver.

Most of the antlers discovered in the galleries of the shafts at Grime's Graves retained their original red colour when found, but in most cases this disappeared when they dried, though ten remained red after sizing—an operation which was accelerated by the primitive practice of dropping white-hot flints, heated in a wood fire, in water until it boiled.

Twenty-nine, some of which were broken, were found in the filling of Pit 1 and 22 in the filling of Pit 2. Four were found in gallery 1 of Pit 1, 18 in 2, 12 in 3, 5 in 4, 8-10 in 5, 10 in 6, 7-10 in 7, 11 in 8, 6 in 9, 10 in 10, 13 in 11, 3 in 12, 10 in 13, 8 in 14, 1 in 16, 2 in 18, 5 in 20, and 1 in 22. In Pit 2, 5 were found in gallery 1, 3 in 2, 9 in 3, 3 in 4, 10 in 5, 10 in 6, 10 in 7, and 4 in 8.

One hundred and sixty-six of the antlers measured were shed, and 32 came from animals which had been slain or died. The average length of the pedicle attached was 2½ in., ranging from ½ in. to 4 in. One of the picks 19 in. long had 4 in. of pedicle attached, another 20 in. long had 2½ in., one 18 in. had 4 in., others were 19 in. + 2½ in., 18½ in. + 3 in. (2), 18½ in. + 2 in., 19 in. + 2 in., 16 in. + 4 in., 18 in. + 2 in. (2), and 17 in. + 3 in. Of picks without the pedicle attached one beam had a length of 29 in., including three tines and the fork of the crown. The remaining length of beam in other cases was 22 in., 21½ in., 21 in. (3), and 20 in. (6). In eleven cases the beam was deeply incrusted with chalk, in one to a depth of ⅓ in. all over, in another with several pounds weight of chalk, while another had flint fragments embedded in the incrustation. Several of these when found retained the finger-prints of the miners on the incrustation, but there were no facilities for studio photography at Grime's Graves, and after drying, some of the incrustation fell off, so that in only one case was it possible to obtain a good photograph of the finger-prints left by the original user of the tool. In this case (Plate XXIV.) the finger-prints were observed before the pick was touched; it was at once protected, and the covering was not removed until it was photographed, so that there is no doubt whatever that the impressions were those left by the hands of the original user. This pick is now in Norwich Museum. In twenty-seven instances the beam was worn notably smooth by the hands of the miners. This smoothness was most prominent on different portions of the beam in different picks,

evidence that the various users did not always handle them in the same way. The beam of a pick from gallery 13, Pit 1, was much gnawed by rodents, as was also the incrustation thereon, and rodents had also gnawed the beam of a pick from gallery 2, Pit 2, and one buried in rubble in gallery 7, Pit 1. A fragment of tine was also deeply clawed. One pick had a deep groove cut round the beam 2 in. from the end of the handle, probably for suspending it. The same pick had a perfect bez tine 2 in. long with signs of wear, and the trez tine quite worn away. One pick had artificial cuts on the beam and trez, and two others on the beam near the burr or coronet, another had three deep parallel cuts 1 in. long above the burr, and cuts on the trez, while another had four parallel cuts $\frac{1}{2}$ in. long on the handle. These may possibly have been marks by which the owners distinguished their own tools. The crown of the antler had been cut off in one case, and in another the bez tine was partially cut through, and then broken off.

Of the antlers which were complete with the exception of the crown, 153 had three tines, 31 had two, and three had four. On four of those with three tines and two of those with two there was a small supplementary tine, while two of the three-tined specimens also retained the forked base of the crown. One antler had a bony ridge connecting the brow and bez tines, and another had a similar ridge 9 in. in length connecting the bez and trez tines.

On 147 specimens the side of the beam opposite the brow tine had been used as a hammer, and in most cases the burr on that side had been worn away, while in some instances usage had resulted in the battering away of the burr and a portion of the beam. Of the 52 antlers which were from animals slain or which died from natural causes, 28 had been used as hammers. There were frequently deep cuts on the abraded portion, possibly from contact with flint in the chalk, or from the pick having been driven into the chalk by a flint hammer-stone. Antlers used as hammers were also found on floors 3 and 13.

In 124 cases there is no evidence remaining that any portion of the antler was removed by fire. In one case there is charring midway on the side of the beam, in another near the burr, and another on the side of the beam near the bez tine. In four cases the antler had been removed from the skull by fire, in one the pedicle and the broken end of the beam had been fired, in others the end and the burr, the skull and the trez tine, the trez and the end, and the skull, end, and trez. In six cases the end and the trez tine bore evidence of fire, in three cases the end and the bez tine, and in 19 cases the end only. The bez tine only had been removed by fire in 8 cases, and the trez tine only in 22 cases.

In one case the circumference of the beam above the brow tine was $9\frac{1}{4}$ in., in two instances 9 in., one $8\frac{1}{2}$ in., five 8 in., three $7\frac{1}{2}$ in., and four 7 in., while in three the measurement of the beam above the bez tine was 8 in., $7\frac{1}{2}$ in., and 7 in.

In the series under review the antlers varied widely. In some the brow tine formed an obtuse angle with the beam, in others an

acute angle. In some cases the brow and bez tine were joined at the base; in one case there was 11 inches between them. In some antlers there was only an inch between the bez and trez tines, but in two there was 11 in., the average being about 6 in. In a two-tined pick the distance from the bez to the end of the beam was 11 in., and in a three-tined pick from the trez to the end of beam was 9½ in.

In 35 cases the brow tine had been broken off, and in 63 cases the end of the tine had been broken and the pick blunted. In 90 cases the point indicated varying evidence of use, while in one case the pick was apparently unused. One brow tine was 11½ in. long, two 11 in., one 10½ in., and six 10 in. The average length of the unbroken but worn tines was 7½ in. In three cases the brow tine had been pared on both sides, apparently with a flint flake, and in one case on one side only, and in five cases the whole length of the tine had been worn quite smooth. One brow tine 9½ in. long had a circumference of 5½ in. close to the beam, and another 6 in. long a circumference of 6 in. In seven instances where the brow tine had been broken off, the bez had been used, its length being 7½ in., 8½ in., (broken), 4½ in., 3 in. (†), while in another case where the brow tine was 10 in. long and the bez 2½ in. both had been used; similarly where the brow tine was 9 in. and the bez one. With the brow tine 6 in. long, bez and trez were both much worn, and on another pick a broken trez 3½ in. long had also been used. A 4 in. bez had been worn quite smooth, and one of the same length with the brow tine gone had also been much used. On one antler the bez and trez were each 3 in. long, and on another 2 in. and 3½ in. A bez or trez tine 10 in. long, attached to a portion of the beam had been used as a pick.

Detached sur-royal tines with the crown of the antler were also frequently used for picks or gouges. In two cases where the crown had three sur-royal tines or prongs all of them were much worn; in two other cases where there were three sur-royal tines only one had been worn. One of these crowns was burnt at the base and the used tine was 6 in. long. In two crowns with two sur-royal tines, one tine on each had been much worn. A further one of similar size had a 4-in. tine much worn, and on it were two parallel cuts ½ in. long. Some of the crowns bore no signs of use. One with four sur-royal tines had three of them broken, and the unbroken one was 11 in. in length. Another had 3 sur-royal tines 11 in. long. A two-tined crown had tines 4 in. long, while on another one of the sur-royal tines had a length of 9 in. and a circumference of 6 in. at the base. Many ends of tines broken off by usage were found throughout the filling-in of the shafts and in the galleries. A tine which had been cut off, presumably with a flint knife, was found in layer 4, Pit 2, and a smaller tine removed in the same manner, at a depth of 2 ft. in the tumulus south section.

The antler-picks are preserved at the British Museum of Natural History; Cambridge Museum of Archæology; National Museum

of Wales, Cardiff; Colchester Museum; Dublin University Museum; Hunterian Museum, University of Glasgow; Horniman Museum, Forest Hill; Hull Museum; Ipswich Museum; Leeds Philosophical and Literary Society's Museum; Leeds University; Greenland Fishery Museum, King's Lynn; Norwich Castle Museum; Reading Museum; Saffron Walden Museum; Royal Museum, Peel Park, Salford; Thetford Mechanics' Institute; Royal Ontario Museum of Archæology, Toronto; and Worthing Museum. Each helper also received an antler-pick. A few are still available for distribution to Museums.

The Flint Implements.

By REGINALD A. SMITH, F.S.A.

The description of selected flints from Grime's Graves will be best followed if preconceived views as to their date and meaning are held in abeyance, and the newly excavated series is considered solely on its merits. Prehistory is growing into a science, and opinions formulated forty years ago should not be considered final, even though they have been accepted almost universally by the present generation. The yield of flints is abundant, and the types to a large extent unfamiliar, but now that the Grime's Graves culture is fully represented, a final solution of the problem is in sight. An endeavour will be made to point out salient features that are also found on other sites, whether in this country or abroad, and the reader will be asked to consider whether such resemblances are accidental or due to contemporary production; and further, whether any recognised culture can be found to embrace all these leading features and thus give the true chronology of Grime's Graves.

Exception may be taken to the very act of selecting from such a large number, but this report must be kept within reasonable limits; and while the most finished specimens are to be seen in public museums,* the remainder is carefully stored and may some day be re-examined in a new light. Descriptions of flint implements apart from illustrations are rarely of any value, hence it is thought advisable to give full details of the specimens here figured and use them as types of an industry that is at present little known and without a recognised nomenclature. Some are at present unique from this site, though familiar elsewhere; others represent whole groups from the Graves, and if accepted as types will go far towards classifying the bulk of the finds.

The mining and knapping of flint still go on at Brandon, and one is tempted to imagine an unbroken tradition in the neighbourhood of Grime's Graves. With identical material, the prehistoric and modern knappers could not well fail to produce some identical forms, and wasters very like specimens from the Graves can be picked out of the modern refuse-heaps; but it is none the less true that at different periods there have been different methods of chipping flint, the resulting products being distinguishable at a glance. One of the great achievements of recent cave-exploration in France and Spain is to have proved once for all that even in late Palæolithic times there were continual changes of fashion, each stage being marked by definite associations, and the individual forms rarely (if ever) occurring at other stages. Though one specimen of a type may be found accidentally in the wrong company, it would be contrary to all experience to find several types associated

* Unique specimens and a full type-series were purchased by the British Museum; museums at Cambridge, Norwich, and Ipswich had preferential treatment; and carefully selected sets were sent to the other subscribing museums.

at one horizon and yet occurring together unchanged at another known to be of different date. It is this ordered appearance and disappearance of flint types that renders possible a classification of surface finds, which are always liable to admixture and disturbance; and the proofs now obtained of prehistoric working to pattern, of faithfulness to type during a given period even over considerable areas, put an end to many idle fancies as to the multiplication of broken or unfinished specimens. The frequency of "broken ends of celts" on sites like Grime's Graves leads to the conclusion that the form was deliberately produced as an implement in itself; and it is hoped that prehistorians will no longer countenance the ridiculous notion that the majority of the Grime's Graves flints are nothing but celts in various stages of manufacture.

Whatever the ultimate verdict as to certain axe-marks in the galleries, one of the outstanding features of this excavation is the total absence of polished flint, or indeed of any other stone in that condition. In some minds there still lingers a suspicion that the basalt celt from Canon Greenwell's pit was not truly *in situ*;* but most prehistorians adhere to the view (one might almost say axiom) that polish was unknown in Palæolithic times and is one of the most definite characteristics of Neolithic work. This article of faith implies that a certain percentage of polished flint implements or fragments should be included in any large Neolithic series. The two most productive sites in England for "Neolithic" flints have been Cissbury and Grime's Graves. The former site has proved very poor in polish,† and apart from the basalt celt mentioned above, the three pits excavated at Grime's Graves have not yielded a single specimen. Two months' continual search on and below the surface entirely failed in this respect, and yet another of the "Neolithic" characteristics is occurrence on the surface. In point of fact, very little is known of the Neolithic period of Britain; and to base that period on finds at Cissbury and Grime's Graves leads to arguing in a circle. Nor is any support afforded to the current view by a third characteristic of Neolithic deposits—the presence of arrowheads, for nothing of that form has come to light during the work. Though many of the flints came from deep pits, they may all in a sense be considered "surface" finds as distinct from those in stratified loams and gravels, but the absence of polish and arrowheads is strong evidence against a Neolithic date; and a close

* This point is discussed in *Archæologia*, LXIII., pp. 111, 147.

† *Archæologia*, LXIII., p. 119: two or three only were found, quite near the surface; and it may be added that the British Museum possesses the cutting-end of a polished celt found in the granular stalagmite of Kent's Cavern (*Report on Kent's Cavern*, British Assoc., 1867, p. 28, the only polished specimen found). Polish has been noticed on blades of La Madeleine date (*Archæologia*, LXIII., p. 148); and that the process is much earlier has been inferred from the discovery of implements so treated in the loess of Predmost, Moravia, "the first discovery of polished stone in a bed of the Drift period," or diluvium (*L'Anthropologie*, 1890, 488). A greenstone celt is said to have been found in glacial gravel at Malton, Yorks., but was rejected by Sir John Evans (his fig. 81, p. 135 of 2nd edn.).

examination of the specimens only confirms the suspicion that a very different culture is here represented.

In what is practically a new industry, it has been often difficult to distinguish between intentional and accidental forms; and though most of the former are corroborated by repeated instances, the latter group may still contain types that will be recognised as such on further acquaintance. But it will suffice in the present report to fix attention on the more striking specimens, selected from an enormous mass of material. The illustrations will give a clearer impression than the text; but some of the more important finds not illustrated will be briefly described according to their horizons, and the utmost use made of analogous specimens figured here or elsewhere. The drawings have been made by Mr. E. J. Lambert under the personal supervision of the writer, and an attempt has been made to give a maximum of aspects and a minimum of shading. The linear scale is given in brackets below each figure.

To save a good deal of repetition it may be stated here that the patination or surface-change of flints from black through blue to white was found to vary inversely with the depth from the surface of the pit or "floor." This is presumed to be due to the greater activity of patinating agents such as rain and sunlight on and near the surface, a view that is borne out by the difference constantly noticed in the two faces of a flint, the upper face having been more subject to these influences than the under face which is normally darker. Thus when the upper face is white, the other side is often some shade of blue; when the former is blue, the latter approaches black; and on the bottom of the pit and in the galleries the worked flints are normally unchanged black.

A just appreciation of the Grime's Graves flint industry is rendered possible only by constant handling and minute study of hundreds of specimens; but it is thought that the outlines of the subject can be made clear by the discussion one by one of the characteristic pieces here illustrated. References to figures are more conspicuous at the beginning of a paragraph than within brackets elsewhere; and though cross-references will be numerous, the groups with their respective illustrations will be taken in the following order:—Pit 1, Pit 2, Floors 1–14 in numerical order, Tumulus Pit, Beaver Pit, Surface Finds.

To economise space, the following museums which have acquired type-series are indicated by their initials:—British Museum, B.M.; Cambridge Archæological Museum, C.A.M.; Ipswich Museum, I.M.; Norwich Museum, N.M.; Hunterian Museum, Glasgow, H.M.G. Specimens followed by Mrs. Hall's name in brackets are retained by the owner of the site, to whom all archæologists are indebted for allowing the Committee to excavate at the Graves.

A description of the implements figured from the two pits and various floors will be followed in each case by a summary of others worth noting from the same source; and the conclusions that may be drawn from the existing material, together with some general observations on the Grime's Graves industry, will close this section of the Report.

PIT 1 (See p. 38).

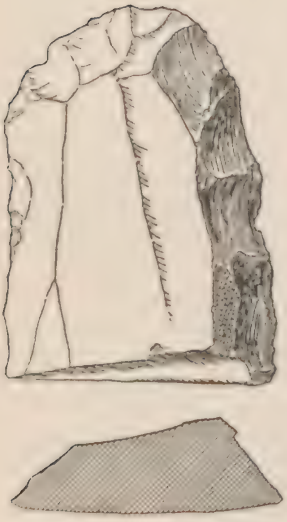


Fig. 19.—End-scraper, top view and section ($\frac{2}{3}$) I.M.

FIG. 19. — An implement that should be of chronological value, but is unique in the present series. It is strictly an end-scraper on a blade (*grattoir sur lame*), but is more massive than usual, and looks like an elongated variety of the common horse-shoe type. The lateral edges are nearly parallel, the butt straight and abrupt, and the ridge not central. The under face is trimmed flat and has a hard white surface, whereas the front feels powdery, a sign of decay in white patina. It is from the top layer, depth $2\frac{1}{2}$ ft.

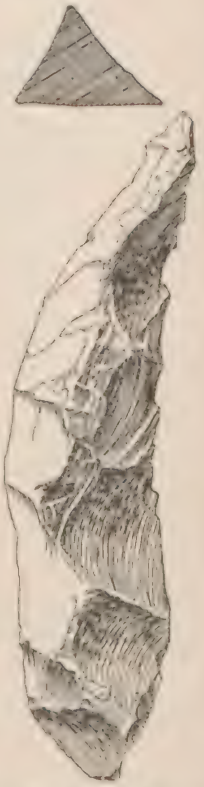


Fig. 20.—Battered back, with section ($\frac{2}{3}$) I.M.

FIG. 20.—Flake of triangular section and one zigzag edge, a form of the "battered back" (*dos abattu*) compared by Dr. Sturge to a crimped skate (*Proc.*, i. 218), his type No. 4. There has been secondary chipping right and left along one edge from top to bottom, and the Doctor remarks that "it is a not uncommon type in the period of La Madeleine, but would seem to be absent in the Neolithic period." The work is somewhat too coarse for the latest Cave period, and an earlier date is suggested by a very similar, though black, specimen in the Pitt-Rivers Museum, Oxford, from the recently excavated cave of Laussel, Dordogne, where it occurred in the Upper Aurignac level. The present example is pure white, and was found at the depth of 4 ft., on an old sand surface at the western edge. Another was found on floor 30 (C.A.M.), with a length of 5·2 in. and points of gloss: it roughly resembles a Cissbury celt, and the broad cutting-edge has angular and rounded ends like an implement

from High Lodge (referred to under Fig. 26) in Dr. Sturge's collection. Finally, a very close parallel from Cissbury is in Manchester Museum.

Fig. 21.—Implement with parallel sides, front and side views ($\frac{2}{3}$) N.M.

FIG. 21.—An implement difficult to classify, but perhaps related to the carinated plane. The creamy white under-face is trimmed flat as if for planing; in which case the thicker end would be the cutting-edge. The other end or butt is broken across, and the parallel side-edges are sharp. It was found in layer 2 (base of layer 1), 2 ft. deep in chalky débris. A somewhat similar tool $5\frac{3}{4}$ in. long occurred on floor 2, and both may have served the same purpose as Figs. 65, 33, or even Fig. 19. It is unknown as a Drift form, but unlike the Neolithic celt, and perhaps its main characteristic is the parallelism of the side-edges. There is a good example from Cissbury, 4 in. long, in Brighton Museum.

FIG. 22.—A "point," slightly curved, with the flat under-face damaged, and the side-edges trimmed in a manner suggestive of Aurignac work, though of the roughest description. It is possible to see in it the successor of the "point" of Le Moustier, and specimens on the same lines but more carefully worked are included in the Aurignac find illustrated in *Jahrbuch für Altertumskunde*, III., Pl. XIII., 3, etc., from the loess of Krems, on the Danube 40 miles above Vienna. It is patinated white, and was found near the east lip, 3 ft. from the surface in layer 3.

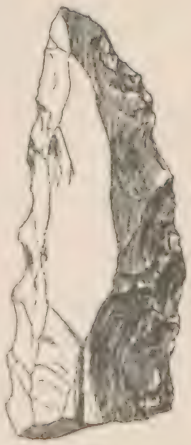


Fig. 22.—Point with flat under-face ($\frac{2}{3}$) B.M.

FIG. 23.—A remarkable implement resembling the tapering portion of a Chelles *ficron*. It is patinated white all over, the chipping moderate, and edges rather zigzag. The pointed end is sharp, and the other blunt and squared, perhaps broken, but possibly complete, as abrupt butts are by no means uncommon in the series from the Graves; compare for instance Fig. 70 which however has one flat face. The specimen illustrated was found in layer 3 at a depth of 4 ft.

FIG. 24.—An implement of the celt family, made, like Fig. 29, of the inferior "wall stone," greyish in colour. The front is irregularly ribbed,

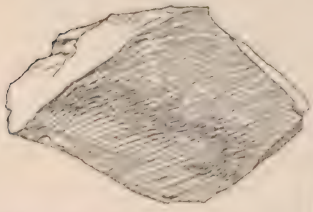


Fig. 23.—Tapering point with view of butt ($\frac{2}{3}$) I.M.

a certain amount of battering being noticeable on the ridges (again like Fig. 29). The under face is rather flatter; the cutting edge regular but not straight, and the side-edges are zigzag. The butt is best described as blunt, without much character; and the section near it is roughly triangular. It was found in a sandy layer (3A) on the top of chalk rubble at the N.W. edge of the pit.

Fig. 24.—Celt-like tool, front and side views ($\frac{2}{3}$) I.M.

Fig. 25.—Implement with cutting-edge like celt, front and end views ($\frac{1}{2}$) B.M.

FIG. 25.—A peculiar form resembling a celt, but slightly out of the straight and the butt thick and abrupt. From the latter, which is roughly of lozenge section, the implement thins and spreads toward the rounded cutting-edge, and the ribbed face is more convex than the other. It is greyish white, probably "wall-flint," inferior to the ordinary "floor-flint" of the site; and was found like Fig. 26 in the black layer (4) at a depth of 10 ft.

The form though far from common is by no means unprecedented. Dr. Sturge has a chalcedonic specimen 4 in. long from Santon Warren, close to Grime's Graves; and there is another in Brighton Museum, with white patina, from Cissbury. Though far afield a specimen in Zürich Museum, from Chamblandes, is worth mentioning in spite of the current view that Switzerland (like Scandinavia) was first occupied by Neolithic man; and an earlier date is suggested by the recent discovery of an allied form in brickearth, with several recognised palæoliths of the same patina, at Castelnau, Hammersmith. In the narrower sense, the Graves specimen is neither a celt nor a hand-axe; the form of the butt is not due to an accidental fracture, but stamps the implement as a type to be included in the growing list from our site.

FIG. 26.—This was one of the sensational finds and may best be described as a "celt," as it corresponds in all essential points to many unpolished specimens assigned to the Neolithic period. Its length is $7\frac{1}{2}$ in., and in this respect it is exceptional, but several others were found in our excavations, and the type can therefore be regarded as fixed. The present specimen is incomplete at the sides, and the probable curves are supplied in one of the drawings. A close examination leaves little doubt on that point, but it is not so easy to find parallels elsewhere, or to trace its development step by step. An important clue is, however, given by the other examples from the Graves, four of which are illustrated (Figs. 36, 55, 61, 75). They range in length from 5·4 in. to 3 in., and further details are

given on pp. 163, 178, 198. The present specimen, which was found in the black layer (4) at a depth of 10 ft., is about twice the average length, and has a sharply pointed butt. The principal cutting-edge is at the opposite end, but both sides were originally sharp in addition, though now damaged, and a zigzag tendency is noticeable. The flaking of the flatter face is mainly transverse, whereas that of the convex face is rather diagonal. It is this inequality of the faces that strengthens the conviction that the prototype was a flake with the bulbar face plain, and this is practically proved by other examples from the site. If the outline alone is considered, a family likeness to the "point" of Le Moustier* will be apparent, but the

Fig. 26.—Celt-like implement, both faces and section ($\frac{2}{3}$) B.M.

reader need not be reminded that the latter is a double side-scraper, the butt not being functional; and a connecting link between these two implements has to be found. A type that seems to fill the gap exactly is well represented in England, and the following list will suffice to show that these are not merely accidental forms:—

Taplow, Bucks. (B.M., Jones Bequest), mottled blue and white

* Mortillet, *Musée préhistorique*, 2nd ed., pl. xi., fig. 77; pl. xv., figs. 114, 115.

patina, probably from brickearth above the gravel of the 50 ft. terrace, L. 3·8 in. (Fig. 56).

Oldbury rock-shelter, Ightham, Kent, a finely worked bluish specimen below the average size (L. 2·8 in.) and two or three others either damaged or less regularly flaked: see *Stone Age Guide* (Brit. Mus., 2nd edn.), pl. 3, p. 68, esp. fig. 1.

High Lodge, Mildenhall (Sturge Colln.), indigo and white patina with crust, bulb at lower angle. L. 4·5 in.

Acton, Middlesex (London Museum, No. A. 13,473), with a crusted facet behind the rounded end of base, but cutting-edge all round. The front is bluish white with hard surface; the back is trimmed rather flatter, and has a decayed white patina. L. 4·4 in.

Creffield Road, Acton (Sturge Colln., No. 2762), collected by the late Allen Brown from a workshop-floor; white patina, upper (convex) face crusted near base. L. 3·8 in.

West Drayton, Middlesex (Sturge Colln., No. 2193), found in loam above gravel, with platform at side of butt, mottled blue-white patina. L. 4·3 in.

Berrymead Priory, Acton (Sturge Colln., No. 63), point missing, longitudinal flaking on upper face, blunt one side of butt; yellow and blue-white faces. Found in fine gravel 12 ft. deep at 45–50 ft. O.D. L. 4·4 in.

Dunbridge, Hants., a creamy white and mottled specimen from the well-known gravel pit, in the collection of Mr. William Dale, F.S.A. The faces are about equally convex, the base with the usual round and pointed ends, and a patch of crust in the centre of it on one face, slightly interrupting the edge. L. 4 in. (*Proc. Soc. Antiq.*, XXIV., 114, top right on plate).

Cognate specimens exhibiting most of the characteristics in question may be noted from Fisherton, near Salisbury (found below mammoth and figured by Sir John Evans, p. 630), also from Thetford, Norfolk, both these being in Salisbury Museum; one of pinkish yellow patina, flaked on both faces, 4·3 in. long, from West Tofts, near Grime's Graves, in Mr. W. C. Wells' collection; and two belonging to Mr. Garraway Rice, F.S.A., found near West Drayton (4·4 in.) and at Copton in Preston, Faversham (3·5 in.).

Le Moustier cavern, Dordogne. In the British Museum series are two good specimens of this outline, both with a point at one end of the base and a curve at the other. One is 3·9 in. long and 2·8 in. wide, both dimensions being one-tenth of an inch more than the Taplow specimen; both faces are black and flaked all over. The other is made from a brown flake, the bulbar face being plain except that the bulb has been trimmed off; it is thickest towards the more rounded side, and there is a *racloir* edge all round, the dimensions being 3·6 in. by 2·5 in. The triangular hand-axe of Le Moustier date is figured by Prof. Commont (*Les hommes contemporains du renne*, Figs. 29, 30), and his Fig. 48, No. 2, has all the features of our Figs. 36, 55, and 75. Further, Lieut. Bourlon

found in the lowest bed at Le Moustier a similar implement 2·7 in. long, of which he published front and side views in *L'Homme Préhistorique*, 1905, 203, Fig. 97, No. 2.

One is tempted to add to this list a black specimen, 3·7 in. long, also from Le Moustier cavern, in Dr. Sturge's wonderful museum, with the bulb in the centre of the lower edge, thus slightly impairing its efficiency as a "celt"; but if a link of undoubted provenance and date is required, this will surely serve to connect the "point" of Le Moustier with Fig. 26. In the same collection are two other specimens from the High Lodge brickearth, made from thick ribbed flakes with steeper bevelling at the base, but in both is seen a feature common to most of the Graves specimens; the lower cutting edge has a right angle at one end and a curve at the other. Though not the case with the largest specimen, this is well seen on the Taplow flint and most of the others quoted above, while it is the rule at the Graves; and the type is referred by Prof. Commont to early Le Moustier.*

Fig. 27.—Implement with one flat face, front and side views ($\frac{2}{3}$) I.M.

FIG. 27.—An implement made of the inferior "wall-stone," with the outline of a celt, but with one flat face. The ridge on the front is more pronounced at the narrower or butt end which is steeply flaked, the cutting edge being unusually thin. It is blue-black, and was found at a depth of 9 ft. in layer 5. It may rank with Fig. 66, which has a twisted appearance and is $\frac{1}{2}$ in. longer; and a third (C.A.M.) 4 in. long was found on floor 3C.

FIG. 28.—A disc that, except for its bluish-white patina, would rank with the large series of late St. Acheul date from the gravels in East Anglia. It is fairly well flaked on both faces and uniformly thin, the edge being zigzag all round. The type is well represented

* *Les Hommes contemporains du renne*, 242, Fig. 86

from the excavations and to some extent no doubt took the place of the hand-axe, but the latter did not finally disappear till the end of

Fig. 28.—Disc, front and back views ($\frac{1}{2}$) B.M.

the Aurignac period (*See* p. 205). It was found 12 ft. from the surface in layer 5.

FIG. 29.—This celt-like implement might well be regarded as a Neolithic intruder; but, though found on the tip from three galleries of this pit, it came almost certainly from gallery 11, and has an exact parallel from the Graves (found at the entrance

Fig. 29.—Celt-like implement, front and side views ($\frac{2}{3}$) B.M.

to gallery 5 in Pit 2). It is of inferior flint (wall-stone) mostly dull black, remarkably thick and heavy with a pointed butt and broad cutting-edge. The section is roughly triangular, one side being squared, the other zigzag, whereas in the other specimen this edge is straight. The squared side is common to both, also the peculiar bruising (recalling the "piquage" of certain Scandinavian celts) of the edges, as if to blunt them.

The flints in layer 1 were practically all white, and several had a powdery surface due to decay and easy to scratch; a specimen thus marked (B.M.) was found at 6 ft. in the rubble of layer 2, but scratches were conspicuously absent from the flints discovered. A curious hand-axe (Mrs. Hall) in layer 1 was made out of calcareous tufa, and at the same horizon were a quartzite hammer-stone (two more at lower levels); a flat square core with alternate flaking as Fig. 60, and a creamy specimen matching Fig. 78 and resembling a primitive graver (*See* p. 202). Only three more specimens need be noted from this layer: an end-scraper on a rough blade 5·5 in. long; a white segmental tool 3·3 in. long, battered in the middle of one edge of the base (p. 165); and a thick ovate flake 4·4 in. long with facetted butt in the Northfleet style (*type Levallois*). At 4 ft. occurred another implement that has a double (floor 3B, both B.M.), and is probably therefore an intentional form. It suggests the sole of a boot and is 4 in. long, with white and blue-black faces, both trimmed flat and the edge all round rather steeply flaked.

In layer 2 was found a steep end-scraper of the dolphin form (as Fig. 31), with lateral but unequal spurs, and the nose undercut or sharpened much like Fig. 68; also a good ovate specimen of Drift type, and two conical implements: one has regular fluting, and neither can be dismissed as a waste core, as that would imply the use of very small flakes.

Another core (B.M.) was in layer 3 at 8 ft., with an engrailed edge, patch of crust at the back and the apex overhanging the base line. There were also in the sandy part of this layer (3A) two flint hammer-stones and a square-ended scraper, a rare form better represented by Fig. 40. Dr. Sturge has another from the "floor" on the Icklingham plateau (*Proc.*, I., 293).

Layer 4 contained among the white flints a certain number with pale blue patina. There was a flat square with alternate long flaking as Fig. 60; also a long ovate implement (I.M.) made of the second quality of flint now called wallstone, another of the same quality and form occurring on layer 5 below, with two spots of gloss just under the crust. A rarity from this layer is a side-scraper *(racloir)* with the two sides worked on opposite faces, and with the black fracture-surface on one face (p. 162). At a depth of 9 ft. was found a massive flake (6 in. by 4·3 in.) with large bulb (B.M.) and facetted butt (as Fig. 43), and at 10 ft. an example of the battered-back *(dos abattu)*, classified by Dr. Sturge as No. 1 (p. 186), 4·2 in. long (N.M.). At about the same level (in the black band) was a celt-like implement (I.M.), ranging in colour from black to

light blue, with rhomboidal section, 4·5 in. long. The outline is a long oval.

In layers 7–9 the flints were mostly black; from the upper level must be mentioned a long irregular lump, 6½ in. long, carefully chipped into a nosed scraper at the tapering end, and a square cutting implement, blue with fair chipping, like Fig. 74. In the next layer (8), at a depth of 26 ft., was a very thin and elegant segmental tool, 3 in. high; and in the sand of layer 9, at 29 ft., an irregular disc much like Fig. 28, but black, blue and white, with chips round the edge shewing bluish-white like many palæoliths from Warren Hill (*Proc.*, I., pl. xv).

At 29 ft. were found two very similar triangular flakes quite black and fresh, with large bulbs at one angle of the base, and measuring 7½ in. and 5¾ in. in length, the longer lying at the entrance to gallery 8. These have the appearance of rough-outs for triangular implements. A black steep-ended scraper of wall-flint, like a pear cut lengthwise and closely agreeing in form and dimensions with Fig. 42, though somewhat engrailed (not worn down by use), was found in gallery 5 running from the floor of this pit; and in gallery 13 was an extraordinary nodule in the form of a T that had been damaged by use as a pick at one end of the head, and roughly flaked at the end of the handle. It is 10 in. long and 8 in. across the top; and may be compared with the antler mining-tools found in numbers on this and other sites. An interesting parallel was found by Canon Greenwell at the bottom of the shaft he explored. "At the end of the second gallery a peculiar-shaped flint nodule was discovered, which is very like a cat's head. It has been used as a hammer and is most conveniently formed for the purpose" (*Journ. Ethnol. Soc.*, 1870, Vol. II., p. 430).

PIT 2. (See p. 70).

FIG. 30.—A small creamy white implement, of very Palæolithic appearance, was found at the base of layer 1. It is a pointed oval, boldly flaked with a sharp edge nearly all round, and measures

Fig. 30.—Patinated hand-axe, front and back views (⅔) B.M.

3 in. by 2·4 in. This was no isolated case, as four more good examples of the hand-axe (*coup-de-poing*) were found in this layer—one of the same outline, but nearly an inch longer; two others roughly ovate, and the fourth almost oblong,* with white and blue-black faces. There are many hand-axes from Le Moustier cavern as small as the one here figured; and as the culture of St. Acheul passed through its various stages, the hand-axe tended to become smaller.

FIG. 31.—A rough bluish-white implement that may be a keeled or carinated plane, and has been compared to a dolphin. The broad top end is almost vertical and the back slopes away to a somewhat pointed butt, resembling a nosed scraper, the flat base being plain. There is no secondary work on the edges, but on either side of the blunt nose is a spur that seems to be intentional

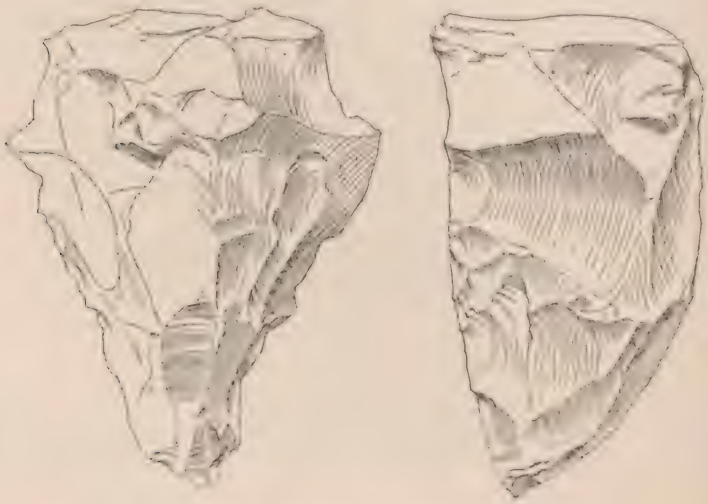


Fig. 31.—"Dolphin" type, top and side views ($\frac{2}{3}$) B.M.

and may be compared with that on several conical implements (Fig. 51). It was found in layer 2 at a depth of 4 ft., and can hardly be regarded as a waster or accidental form, as its fellow was found on floor 12 (N.M.), and a third somewhat longer on floor 3B. Nor is it without significance that a close parallel was found in one of the Peppard pits by Dr. Peake.†

* Compare specimen from Peppard, Oxon. (*Arch. Jour.*, LXX., 46, Fig. 9).

† *Arch. Journ.*, LXX., 53, Fig. 18 (length 4·6 in.).

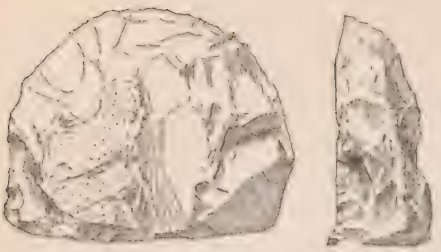


Fig. 32.—Segmental tool with flat face, front and side views ($\frac{2}{3}$) C.A.M.

FIG. 32.—Segmental tool (or "tea-cosy") with one flat face which is blue-black; some crust on the blue-white front. The rounded cutting-edge is good with secondary work, and like most well-made segmentals it stands upright on a level base. A rougher example from the same level is about half as long again, and Dr. Sturge has a black specimen from Le Moustier itself $2\frac{1}{2}$ in. long, made from a flake. It may prove necessary to distinguish this variety from the segmental with both faces convex; and the former may provisionally be compared to the toe-cap of a boot. The present example came from the black band (layer 3).

Fig. 33.—Implement with parallel sides and chisel end, top and side views ($\frac{1}{2}$) B.M.

FIG. 33.—An implement of oblong plan, one end roughly shaped like a chisel, the other a thick squared butt (*cf.* Fig. 21). The three edges are sharp but bevelled, the under face being trimmed flat, with bluish-grey or white patina. It was found in the black band (layer 3), and is difficult to classify, but does not stand alone. A specimen sharp at both ends and half as long again, but otherwise similar, is figured from floor 3B (Fig. 59). Mr. J. Davis has an implement 5 in. long, of the same general form but with a more oval section, found in the loam bed at Wansunt, on the 100 ft. terrace of the Thames at Crayford; and it seems best to regard it as a short and early form of the well known "Thames pick" (the Campigny *pic* of the continent), which has also been found in gravel more than once. The rudimentary pick also figures in the Cissbury series,* and Weeting itself has produced a finely worked implement† 3 in. long that may well belong to the same category.

FIG. 34.—An ovate implement of uncompromising Drift type, with cutting-edge nearly all round but doubled in one part. It is almost circular but differs from the typical disc of the gravels in being comparatively thick at the centre. One face (no doubt the upper one, as it lay in the black band) is patinated white, flattish and regularly flaked; the edges to some extent follow a zig-zag line;

Archæologia, LXIII., p. 155. †*Ibid*, p. 113, Fig. 5,

and the other face is white near the edge and blue-black at the centre, with a large patch of original black surface, which is doubtless due to a fracture in the raw material and is of frequent occurrence. A good example of differential patination, and a form very

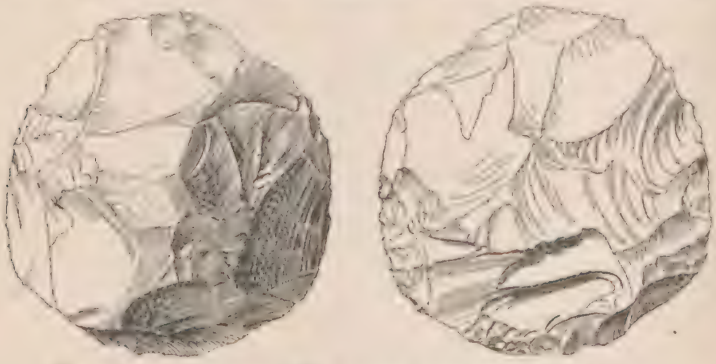


Fig. 34.—Implement of Drift type, front and back ($\frac{1}{2}$) B.M.

difficult to fit into any Neolithic scheme: only in desperation could one deny that this is a hand-axe (*coup-de-poing*) or that this easily recognisable type passed out of fashion before the end of the Cave period. The dilemma crops up again and again in considering the flint products of the Graves.

Fig. 35.—Scraper, chiefly used at the side ($\frac{2}{3}$) B.M.

FIG. 35.—A beautiful oval scraper, made from a flake with white front and greyish bulbar face, the latter being quite plain. This by far the best of the flake-scrapers was found in the black band at a depth of 12 ft, and, as a masterpiece, should throw additional light on the industry to which it belongs. The edge has been trimmed or used all round except at the bulb where some facets are noticeable, in the Northfleet style.

FIG. 36.—No excuse is needed for figuring another of this remarkable type, as a good deal depends on its correct classification. Both faces are blue, and the curve on the left ending in a rounded angle below is more characteristic than the other which joins the cutting-edge at a right angle, as is frequently the case. The back is flatter, the butt pointed, and the edge carried all round, the edge-working in this specimen being confined to the flatter face (back). It was found at a depth of 14 ft.; and, even apart from similar specimens, would

have to be considered *in situ*. The form is also discussed under Figs. 26 and 55, and it only remains to add that in point of size this specimen is about midway between the two.

What seems to be a parallel form but an inch longer is figured by Engerrand, *Six leçons de Préhistoire*, III., Fig. 37, and described as a "coup-de-poing de forme allongée," from Binche, Belgium.

Fig. 36.—Celt-like implement with pointed butt, front and back (½) I.M.

FIG. 37.—One of the many surprises at Grime's Graves was the discovery in layer 5, at a depth of 20 ft., of a large lump of black and grey flint, 6·5 in. by 6·1 in., and 4·6 in. thick at the centre, exactly corresponding to an unstruck "tortoise-core" from the Coombe-rock at Northfleet, Kent.* The type has been recognised independently on the Thames and the Somme, and assigned on abundant evidence to the period of Le Moustier (Levallois facies). The first essential was to obtain a regular oval outline by flaking above and below a line not in the central plane, the underface being the more conical and often left with crust in the centre. The upper face was trimmed convex by blows from the circumference, and after that process a blow was given at the butt to detach the implement ready-made. This method of manufacturing one-faced hand-axes was both elaborate and extravagant, as the struck cores were thrown away freely at Northfleet, Montières, and certain other places in North France where raw material was abundant; and though other inferior specimens were found at the Graves, it is probable that the same workmen or their successors continued to utilise most of the tortoise-cores, which cannot now be recognised as such. The history of the present specimen is fairly obvious. The preliminary trimming was on the point of completion when the removal of a flake from the top disclosed a natural cavity 1½ in. deep, that would have produced a hole in the implement if the block had not at once been discarded as worthless. Further, its symmetry is impaired by a bedding-plane at one side and at the butt is a lozenge of crust, another sign that the work was arrested,

* *Archæologia*, LXII., p. 522, Fig. 1, shows one with the flake-implement removed from the flatter face. It is here reproduced (Fig. 38) by kind permission of the Council of the Society of Antiquaries of London.

as the butt was generally facetted before the implement was detached. Miss Layard has recently presented to the British Museum another unstruck specimen, about half the weight, found on the surface in the neighbourhood of the Graves; Dr. Sturge has one, 5¾ in. long, from the "floor" under sand on the edge of the Icklingham plateau; and our excavations produced about half-a-dozen blocks that may rank as tortoise-cores now that an indisputable example of this peculiar type has made its appearance. It is open to anyone to maintain that a method that commended itself to Le Moustier man might have been adopted or re-invented at any date in the Stone Age; but the fact remains that the type is not ubiquitous; it is in the nature of a novelty, and practically confined to an horizon that can be dated much more accurately than is generally the case with valley-deposits. For further confirmation of this view, the reader is referred to other coincidences discussed on pp. 201, 205.

Fig. 37.—Unstruck "tortoise-core," top and end views (⅓) B.M.

In layer 1 nearly all the worked flints were white, only four of a bluish tint being noticed in the collected series. Besides the hand-axes already mentioned, there was a specimen of the "battered back," with triangular section, 3·4 in. long, with one edge trimmed; a white ridged flake (H.M.G.), 4 in. long, with the characteristic facetted butt; and a conical implement with steep fluting 2·6 in. across and 1·7 in. high (H.M.G.). Heavy choppers of the segmental type were also comparatively common in this pit, good examples occurring in layers 1, 2, and 5, the lengths being remarkably uniform (3·8, 3·7, and 4 in.), both faces being flaked convex and the base a pointed oval. A globular hammerstone of flint (N.M.) was found here at 2 ft.

There was a good ovate hand-axe in layer 2, with one face quite flat, length 4·5 in., and a well-made point that may have belonged to another variety. A perfect hand-axe, 3¾ in. long, with one flat face and sharp but sloping butt (B.M.) occurred in this layer at 7 ft.; it closely resembles one from Cissbury in Brighton

Museum (*cf.* floor 3c). A remarkable flake (I.M.) with white and bluish faces has a long side-edge worked in the manner of a Le Moustier *racloir*, the opposite side being jagged and the base steeply flaked. The length is 4·5 in., and there are some lines of gloss. At 3 ft. was found a curious lump with steep and engrailed

Fig. 38.—Struck "tortoise-core" from Northfleet, Kent, top and end views (½) B.M.

edges, a rounded projection or nose and almost flat base, closely resembling specimens from Peppard* excavated by Dr. Peake, and one in the British Museum found on a brick-earth floor at Gaddesdon Row, Herts., by Mr. Worthington Smith, in association with St. Acheul types. Two segmental tools from this layer must be

* *Archæological Journal*, LXX., p. 61, Fig. 24. There is something very similar from Cissbury in Manchester Museum.

noticed on account of the battering in the middle of one edge of the base, as if in imitation of the hinge-fracture that is often seen in that position (*cf.* p. 178). Their lengths are 4·1 and 4·8 in. A "Northfleet" flake with the regulation facets on the butt measured 4¾ in.; an implement 5¼ in. long resembled a Thames pick of triangular section; and a triangular white flake with scraper edge in Le Moustier style may be matched from the classic cavern itself.*

Layer 3 contained flints with white patina as before, but also bluish and a few bluish-grey specimens, black surfaces being generally old black fractures in the raw material. A thin white square of 3·5 in. had one of its two blunt edges furnished with a hinge; and there was another large flake with facetted butt, half an inch longer than that mentioned from layer 1.

A feature of layer 4 was the preponderance of thickly crusted pieces, evidently made of the "floor flint" which the miners went so deep to secure. Two hand-axes were rough and thick, and a third triangular with plain convex face, the other trimmed, with crust and original black patch. A regular black ovate had one flat face and a blunt butt, and another flattish ovate of bluish tint resembled Chelles work. There was one good blue-black disc, thickest near the edge, and a thin chopper with mottled patina on the thick edge or back where the hand would rest. Examples of the square cores (as Fig. 60) with alternate flaking were found, and one white cone with narrow oval base; another was more domed, with crust on the apex.

In view of a similar find in one of the Cissbury shafts,† the flint flake, 5 in. long, found below the human occipital in layer 5 may be significant. It may be called an end-scraper (H.M.G.), the white face trimmed at one side, and the bluish face quite plain. Another find of interest was a lump suggesting the tortoise-core of Northfleet, and this identification is supported by the unmistakable specimen already mentioned from the same layer (Fig. 37). A symmetrical ovate implement (B.M.), 3·6 in. long, has the convex face black and crusted, and the other flat, the butt being blunt. At this point in the British Museum series the black specimens begin, but in the same layer was a rough segmental tool (B.M.) with slight battering on one edge of the base; one face has a hard white surface, the other is white but powdery and much more decayed. An exaggerated form of the undercut core (B.M.) was also found in this layer at 20 ft.; it is black, with the beginnings of patina, and has the form of a champagne cork, but is 2·9 in. high, and probably served as a scraper. Only short flakes have been detached, and there is no evidence of the use of such flakes at the Graves, where large implements were the rule, whether made from flakes or nodules.

In the black band (about 13 ft.) was a shield-shaped implement (B.M.), 3·9 in. long, with one face flat, white all over with three

* *Reliquiæ Aquitanicæ*, Pl. XL., Figs. 2, 3.

† *Journ. Anthrop. Inst.*, VIII., 377; VII., 431; *Archæologia*, LXIII, 125.

spurs at the top divided by two notches, much like Fig. 71. But for the second example this might have been treated as an accidental form, and an ovate implement from Whipsnade, Herts., shows that it was also a Drift form (p. 177). An extra notch at the side corresponds in position to the lance-rest of a mediæval shield.

At 16 ft. was found a fine cordiform hand-axe, blue-black in front, and darker on the flatter face; it measures just over 4 in. in length.

Two feet from the bottom was found a flake 5½ in. long with the butt facetted in the Northfleet style; and the galleries of Pit 2 were fairly productive. From No. 6 came a segmental chopper (B.M.) with a false hinge (produced by battering the centre of one edge of the base); it is 4·1 in. long, and has both faces convex. Its somewhat square outline recalls a specimen (B.M.) with the same false hinge from floor 13, 3½ in. long. Gallery 3 produced a large black end-scraper (B.M.) with the under face quite plain; it is 5 in. long, about half the length of another found at a depth of 24 ft. and trimmed only at the rounded scraper-end. Both these are still very sharp, and quite unchanged.

FLOOR 1. (See p. 99).

FIG. 39.—A flake-implement, bluish white on the back where it is trimmed flat; the front with longitudinal rib not central, speckled blue-black. On the left side the edge is that of a *racloir*, on the right it is rather jagged, as if from cutting. A fine specimen,

Fig. 39.—Implement with one flat face, front and side views (⅔) C.A.M.

perhaps imperfect; another example of the unequal patination of the two faces, the less patinated having been below. Though an exceptional form, it is practically identical with one from St. Acheul, also with different patinas on the two faces, and referred by Prof. Commont to the period of Le Moustier (*Les hommes contemporains du renne*, 109, Fig. 45, *cf.* pp. 94 and 91, where he speaks of the under or bulbar face as reddish Drift patina, and the white upper flaked face as early Cave period).

Fig. 40.—Scraper with square end ($\frac{2}{3}$) B.M.

FIG. 40.—Among the varieties is the square-ended scraper here illustrated, and the form is uncommon at any period. It is formed from a flake of which the bulb remains at the side of the butt: upper face white, and the other bluish and quite plain. Another of less regular shape was found in layer 3A, Pit 1; and reference may again be made to Dr. Sturge's collection, which contains a specimen rather broader towards the butt, but almost exactly the same length, from Le Moustier cavern itself, and there are several from the same site in the British Museum. In these circumstances the coincidence is of special significance; and forms that cannot be matched anywhere but in Le Moustier deposits must be recognised as cumulative evidence.

FIG. 41.—A large coarsely flaked cone that might be taken for a nucleus, but is marked out as complete in itself by an old black surface at one side and a spur resulting from two notches on the edge of the base immediately opposite the unchipped part of the cone. Both these distinguishing marks might be dismissed as accidental in one or two cases, but many of the Grime's Graves specimens have both (Fig. 51) and some have one or the other. The French call smaller specimens from cave-deposits of the Aurignac period *grattoirs Tarté*, and repeated cases of secondary work on the lower edge support the view that they were indeed used as steep-faced planes; but the addition of a spur in the centre of the trimmed edge may be a local peculiarity, though the *grattoir museau* or nosed scraper is also a common Aurignac form. The spur also occurs in the centre of almost oblong flakes (p. 177), and was evidently required for a special purpose; but the present specimen is selected for illustration on account of its unusual size and the possession of a definite back left untrimmed. If this were merely a core, there is no reason why flakes should not have been taken off all round, as the base in this and many other specimens is approximately circular. In smaller specimens known to date from the Aurignac period, the apex is central or eccentric; and both forms are represented, but as usual of rougher workmanship, in

the Graves series. The present specimen is bluish on the chipped portion of the cone, and has a fairly flat base, of the old black surface often referred to. By modern standards it would not be an effective implement for scraping, but represents a whole series from the Graves, and may well have served the same purpose as the Aurignac cone. The resemblance in form is for the present more important than the method of using the implement.

The worked flints from floor 1 comprise several rough hand-axes of unsymmetrical outline but clearly recognisable as such. A lump with flat base trimmed upwards more or less to a cone, with a

Fig. 41.—Cone with spur, side and top views (½) B.M.

squarish projection or nose on the base level is a form that might well be thought an accident, but closely corresponds to specimens from Peppard (*Arch. Journ.*, LXX., 48, Fig. 11) and the brick-earth "floor" discovered by Mr. Worthington Smith at Gaddesdon Row, Herts. (B.M.). One crusted nodule (B.M.), 4·9 in. long, had the steep end engrailed, perhaps for the same purpose as the "dolphin" (Fig. 31), but the constriction in the middle reminds one of the "waisted" implements so common in Dorset (*Archæologia*, LXIII., 153, Fig. 38), and occasionally found on the Downs, nor should the Peppard parallel be omitted (*Arch. Journ.*, LXX., 47, Fig. 10). The retention of so much crust in the present case was due to the very convenient shape of the nodule.

One square flake was noticeable for its facetted butt,* a constantly recurring feature on this site, and two end-scrapers on blades are among the varieties, one (B.M.) being 3·2 in. long, but not comparable in finish with Fig. 62. A white implement (B.M.) that has a close parallel from floor 2 (N.M.) and is therefore probably not accidental, may be described as shoe-shaped, with parallel sides, one face flat and the other thickening towards the rough butt. It is 4·1 in. long and agrees in all essential points with one from the well-known Le Moustier site at High Lodge, Mildenhall (B.M.),

* Prof. Commont states that this feature is not found in the earliest Solutré period (*Les hommes contemporains du renne*, 371); and it may therefore be regarded as characteristic of the Le Moustier period and not later than Aurignac.

4 in. long. The thin curved end and one side are worked in Le Moustier style (whether due to trimming or use for scraping); and a still more striking example of one-faced edging is a triangular flake (B.M.) with steep bevel,* having along a broad ridge an older creamy-white patina that has turned soft and begun to decay. The occurrence on one flint of two surfaces that must be of different dates† is rare enough at the Graves to attract attention.

A prismatic tool (N.M.), 3 in. long, is broken at both ends, but the trimming and blunting of the side-edges, presumably to give a firm hold, are unmistakable, and it may be regarded as a larger specimen of the type (Fig. 48). This floor also yielded an example (B.M.) of flint stained and to a certain extent incrusted with iron, that contrasts strongly with the normal black-to-white coloration.

FLOOR 2 (See p. 99).

FIG. 42.—End-scraper resembling in shape half a pear, with broad scraping end steeply flaked, and some dappled crust on the bevel; a prominent central rib and tapering butt. Both faces are bluish-white and the under face is concave towards the broad end so as to increase its utility as a scraper, a feature that is frequently observed on this and other sites.‡ In shape it is almost identical with one made of poor and dull black flint from gallery 5 on the floor of Pit 1, also in the national collection: there is only one-tenth of an inch difference in length. At Cissbury it is one of the most characteristic forms, but these two stood out as the best examples of the type in the Grime's Graves series, though one from the base of layer 1 of Pit 2 is the same length and worthy of notice.

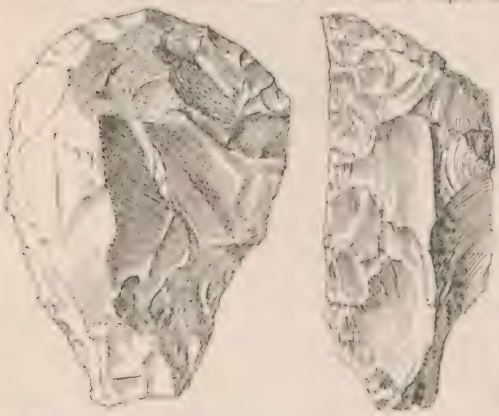


Fig. 42.—Steep-ended scraper, top and side views ($\frac{2}{3}$) B.M.

On this floor there was a noticeable amount of flint with peculiar crust, varying from one-sixteenth to $\frac{1}{4}$, $\frac{1}{2}$, or even $\frac{3}{4}$ in. in thickness. It is a dull yellow with minute black spots on the surface as well as lighter markings in broad crooked lines or patches; and

* Many similar examples have been found at London Bottom, Icklingham, shewing hard and soft white patinas on surfaces flaked by man.

† *Cf.* Le Moustier specimens in *Reliquiæ Aquitanicæ*, pl. XL., Figs. 2, 3.

‡ A good example from Cissbury is illustrated from the side in *Archæologia*, LXIII., 128, fig. 27.

very little black flint was noticed with this crust, the patina being normally white.

A good hand-axe (B.M.), 5 in. long, has large but fairly regular flaking on both faces, a pointed oval outline and somewhat zigzag edge; other Drift types were two fine implements between the disc and ovate (I.M.), with the under-face trimmed flat, and the front sub-conical, the lengths being between 4 and 5 in. The crust on three rough segmental tools from this floor (C.A.M. and I.M.) shews they were not broken celts; and there was another example of the "dolphin" (as Fig. 31), with the under-face trimmed and not a plain fracture. A steep-nosed scraper with engrailed edge somewhat resembles a horse's hoof, of which a more finished specimen is described on p. 199. A thin flake (C.A.M.), 4·4 in. long, of lozenge form, has a carefully trimmed and strong point, manganese spots appearing on both faces; and two scrapers (B.M.) are of recognised Le Moustier forms—a ribbed flake, 5 in. long, with sloping scraper-end terminating in a point on the left (much like Fig. 71); and a triangular flake with *racloir* edge like one from floor 1 (p. 170). A shoe-shaped implement (N.M.), 5 in. long and with similar edge, has already been referred to (p. 169); and a fair specimen of the cone (I.M.), 1½ in. high, has a blue-white patina and concave base. A heavy crescent, 6 in. long (N.M.), has the ridges battered and both faces flaked, the front being covered with incipient bulbs of percussion; and a somewhat similar tool is figured from Abri Audi (*Actes de la Soc. Linnéenne de Bordeaux*, LXII., pl. XX., Fig. 9). A specimen of the toe-cap type (C.A.M.) measures 3 in. by 2½ in., and among over a hundred flints from this floor were pieces of hammer-stones, one quartz pebble used as a hammer, and longish blades or splinters, but nothing approaching the number or quality of types in floor 3.

FLOOR 3c (See p. 100).

Fig. 43.—Ovate flake-implement, top view with facetted butt ($\frac{2}{3}$) B.M.

portion of a pear cut longitudinally, but not through the centre. It has a cutting-edge all round, but the back is quite plain and flat, with a darker patina than the convex front. The broad end might have been used as a scraper, but such a use would not account for the edge all round, and it seems the wisest course to regard it as a one-faced hand-axe, the use of which most archæologists are content to leave a mystery. There is said to be a limit to the survival of the hand-axe in the Cave period, and one-faced implements would, in the absence of contradictory evidence, be most naturally assigned to the period of Le Moustier.

FIG. 43.—A flake-implement which would be assigned to the Northfleet type on its own merits even if a still better example had not been found on the surface in the immediate vicinity (Fig. 77). The surface flaking of the upper or convex face is bold and effective, having been effected (if the attribution is correct) before the implement left the core (of the "tortoise" pattern as Fig. 38). The butt is well facetted, and the under-face plain and concave, the whole being patinated bluish grey. This type is now familiar, from large finds in the Thames and Somme valleys, but seems to be restricted to one horizon and is easily distinguished from other forms, even of the same outline.

FIG. 44.—This implement resembles in shape the thinner

Fig. 44.—Implement with one flat face ($\frac{2}{3}$) B.M.

Fig. 45.—Implement with thick and narrow butt, top and side views (⅔) N.M.

Fig. 45.—A curious implement that, except for its thicker and rather pointed butt, might be compared with Fig. 21. It is bluish-white, with one flat face and a celt-like cutting-edge. It may be an accidental variety of the type with parallel sides, but whether that parallelism was essential is at present unknown.

Fig. 46.—This specimen might pass unobserved in the large series from the Graves, or be put aside as an accidental form of flake. There are, however, two others (B.M. and I.M.) identical in all essential points from the same floor 3c, and all might be included in the Abri Audi group, which is placed by the French experts between the periods of Le Moustier and Aurignac.* As will be seen later, these flake-tools furnish evidence of a most valuable kind, but belong to a type not well known in this country and therefore in need of further description. The main features of the Abri Audi "point" are the curved and straight side-edges, though the definition must remain very elastic. The former is generally thick and battered or flaked across as if for a finger-rest; and the latter is generally thin and sharp, often jagged as if by use as a knife. The three specimens from floor 3c are therefore fairly true to type, ranging in length from 2·5 in. to 3·4 in., and all have the side-edges trimmed or flaked by use only on the upper face, the lower (bulbar face) being quite plain. The one figured is patinated bluish-white, and has the curved side steepest near the point. Another, 3·2 in. long, from the well-known Le Moustier deposit at High Lodge, Mildenhall, is included in the Greenwell collection acquired by Dr. Sturge; and another called "un couteau racloir à dos abattu rappelant les couteaux acheuléens" is figured by Prof. Commont (*Les hommes contemporains du renne*, 119, Fig. 52, No. 4) from the base of the *ergeron*.

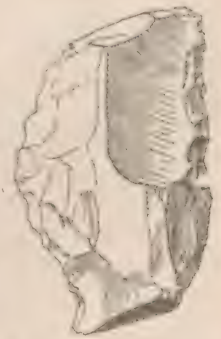


Fig. 46. Flake with thick curved back and straight cutting edge (⅔) B.M.

* *Revue mensuelle de l'École d'Anthropologie de Paris*, 1909, 330, the typical "point" being well illustrated on p. 326. A good specimen from Le Moustier cavern itself is in the British Museum.

Fig. 47.—Flake of triangular section, with one side notched, top and side views ($\frac{2}{3}$) B.M.

FIG. 47.—A steep-ended scraper made from a flake of triangular section. On the right of the central rib it is black, the rest of the surface being bluish grey. The fluting at the end is slight, and the interest of the specimen lies mainly in the two notches on the left side, which can hardly be accidental; and if many other coincidences are accepted as cumulative evidence, the notches (*encoches*) are quite in order. One of the leading characteristics of the Aurignac period is this treatment of the edge; and it has been pointed out by the Abbé Breuil* that though Drift implements are sometimes provided with one or more notches, the frequency of this feature during the Aurignac period is remarkable. What seems to be a parallel form, but with only one lateral notch, was found at Les Rebières (near Brantôme, Dordogne), a "station" of Le Moustier date, described at the Geneva Congress of 1912 *Compte-rendu*, Vol. I., p. 474, Fig. 16, No. 8.

FIG. 48.—This is undoubtedly the best specimen of the prismatic tool from the site, though there are several larger, either complete or fragmentary, and one nearly as good (I.M.) $\frac{1}{4}$ in. shorter, from the same floor 3C. The under-face is a plain and perfectly level fracture; the sides, tapering to the point but parallel towards the butt, are trimmed, to save the fingers in use, by blunting the edges, and the point itself is fairly steep and more or less fluted. The trimming in this instance is supplemented by minute flaking on the very edge, as on the cone (Fig. 41), a feature that has been observed on many Suffolk specimens by Mr. G. J. B. Fox, who compares it with pygmy work. The present specimen has a triangular section, a median ridge running along the upper part, but in many cases the section approaches a trapezoid, the top-side being parallel to, but narrower than, the base. It may be mentioned that a surface specimen in Mr. Fox's collection was exhibited at the International Prehistoric Congress at Geneva in 1912 and accepted by two of the leading specialists as an Aurignac type. It is represented in the loess of Krems on the Danube, 40 miles above Vienna, and a developed

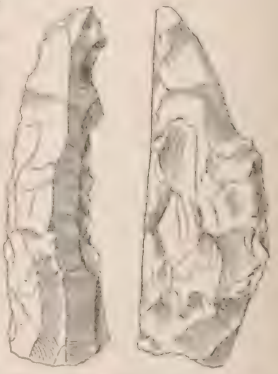


Fig. 48.—Prismatic tool, top and side views ($\frac{2}{3}$) B.M..

* *Revue de l'École d'Anthropologie de Paris*, 1909, 332. For parallels from Abri Audi, see his Fig. 162, Nos. 60, 63, p. 330.

form is classed as mid-Aurignac (Geneva Congress, I., 173, Fig. 6, No. 6).

Reference may also be permitted to one found at Weeting (B.M.) by Canon Greenwell in 1868, and to a Cissbury example of the type, figured in *Archæologia*, LXIII., 127, Fig. 19; there is another from the Sussex site, 3½ in. long, in Manchester Museum. It seems evident that the prismatic end-scraper is nothing but a narrower form of the nosed and carinated plane (*grattoir museau*). The transition is well illustrated in the first vol. of the Geneva Congress, p. 470, Fig. 13 and p. 477, Fig. 18, No. 4.

Fig. 49.—Prismatic tool with handle, top and side views (⅔) B.M.

FIG. 49.—A prismatic tool of the same type as Fig. 48, but furnished with a handle in the form of a gabled butt. Dr. Sturge has a similar prism with thick handle from Cissbury, with the same white patina; and another is included in the Northfleet series (B.M.).

FIG. 50.—Many of the cones from Grime's Graves, be they merely cores or finished implements, are large and rough, but the present specimen is beautifully patinated, smooth to the touch, fluted with some regularity and of dimensions that emphasize its resemblance to a classical type of the Cave period. The plan is oval, the base trimmed but still uneven, and the conical part fluted all round, except for a small patch of crust, the apex being as usual not quite central. The patina is creamy white, with a tinge of blue in places (the result of the original black shewing through a film of white); and the finest work is round the edge, which runs in an even line. It is at the outset improbable that such care would be lavished on a nucleus that was merely refuse, and that theory implies that the

Fig. 50.—Fluted cone, top and side views (⅔) B.M.

workers at Grime's Graves were making use of the detached flakes, or rather splinters, which at once involves a pygmy industry, of which there are no other traces; in fact the local industry obviously tends towards the other extreme. If then this specimen is a conical implement, parallels should be forthcoming, and anyone familiar with the Cave industries will at once recognise it as a *grattoir Tarté*, so called from a cave of the Aurignac period in Haute Garonne where they were common. The French name implies that they were used as end-scrapers, and several from different English sites have minute flaking on the edge such as would result from that operation; but as other specimens have not been so used and were possibly never intended for such a purpose, it is proposed to retain the non-committal term of "flint-cone." Comment was made in 1912 on the fine example found by Canon Greenwell at the Graves (B.M.), and many from various English sites might now be added to those cited in *Archæologia*, LXIII., p. 114, Fig. 10.

FIG. 51.—An interesting though rough example of the cone, presenting features less well seen in the more finished implements. The patina is white, bluish near the apex, with thick dappled crust (as on "floorstone") at the right side of the top view, and an old black surface flecked with white at the back. There is generally a part left roughly shaped opposite the front or finished edge by which the scraping (if any) was effected; and in this, as in several others,

Fig. 51.—Conical implement with spur, top and side views (⅔) B.M.

the middle point of the front is accentuated by a spur, which is not merely the expanded base of a ridge between two facets but an essential part of the implement, and sometimes flanked by deep notches. Canon Greenwell found a good example (B.M.) at the Graves, and this spur occurs on other forms, such as Figs. 52 and 53, and is normal on the cones.

Fig. 52.—Blade with spur at end ($\frac{2}{3}$) B.M.

FIG. 52.—A broad blade with two longitudinal ridges and in the middle of one end a spur emphasized by a notch (*encoche*) on either side. There is thin crust on the right bevel, but the patina is mostly pale blue, and the underface quite plain. In the middle of the left edge is an intentional notch, and in view of other spurred examples (Figs. 41, 51, 53), one may regard this as a definite Grime's Graves type, Canon Greenwell having found one (B.M.) in his pit at a depth of 10 ft. Its beginnings seem to be in the St. Acheul period, Mr. G. J. B. Fox having ovate hand-axes from Warren Hill treated in this way at the point; and Mr. Worthington Smith has one found at Whipsnade near Dunstable.

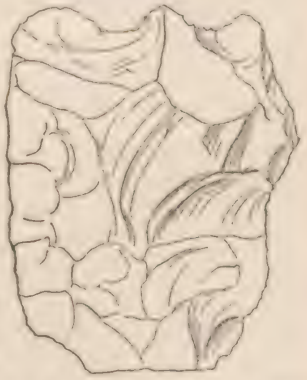


Fig. 53.—Implement with spur and notches ($\frac{2}{3}$) B.M.

FIG. 53.—An implement that might at first be taken as the middle portion of a chipped celt, but is complete in itself, and of special interest as a type, another coming from floor 2 (I.M.), and a third from floor 3C (B.M.) Both faces are flaked convex, the edges fairly straight, and the butt of lozenge section much like that of Fig. 25. The front here figured is blue-grey merging into white, and at the broad end has three points or spurs separated by two worked notches. The three spurs are joined at the back by a bevel of one flake, and the centre is the most effective, its extremity being in the same plane as the middle line of the face whereas the other two are in the middle plane of the side-edges. That an implement of this kind was used and manufactured at Grime's Graves is indicated by other varieties, such as Figs. 51 and 52, and the workmanship is certainly not that of a waster or accidental form.

FIG. 54.—Perhaps the finest piece of work discovered during the excavations, and one that should give a key to the industry, though there is always a danger in judging by the unique or choicest specimens. It is hardly a "point" or "leaf-shaped blade" in the technical sense, but partakes of the nature of both, having both faces convex, one face pale blue and slightly flatter than the other, which is white. The sides have an outward curve much like Figs. 26 and 70, and taper to a sharp point. At the other end there is a

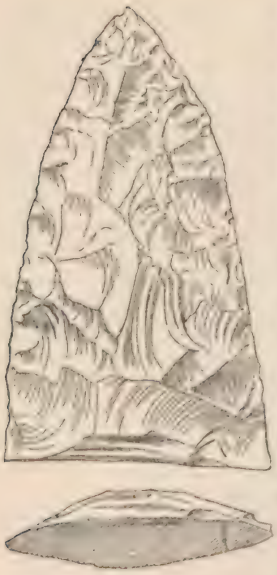


Fig. 54.—Pointed implement flaked on both faces, front and end views ($\frac{2}{3}$) B.M.

transverse fracture, not quite straight, that might be regarded at first sight as accidental; but this is improbable on two grounds. In the first place the squared fractures forming the base of certain implements from the Graves (as Fig. 74) are intentionally on the slope; and secondly in the centre of the more convex edge of the butt is a hinge fracture that brings this into line with a considerable number of specimens fractured in this way apparently of set purpose, or battered in the same spot as if to imitate the "hinge" (Fig. 70 and p. 165). If the implement is complete it cannot rank with the typical celt-like form, with which it agrees in all but the cutting-edge; but as it is not known how the hinge-fracture was produced at will, it is always open to regard the fracture at the broad end as accidental and to replace in imagination a lost cutting-edge. Against this interpretation, however, is the existence of a close parallel,* half an inch longer, with the same sloping butt, found by Canon Greenwell near Grime's Graves over forty years ago and now in the national collection. Whatever its precise use and original outline, the new specimen is certainly a masterpiece of surface-flaking, and as hinted earlier in this paragraph, may stand midway between the "point" of Le Moustier and the "laurel-leaf" of Solutré.

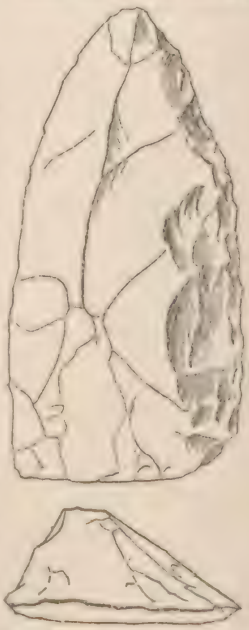


Fig. 55.—Implement with pointed butt, top and end views ($\frac{2}{3}$) B.M.

FIG. 55.—This celt-like implement is one of the most important and illuminating finds from the Graves, and should be viewed in connection with Figs. 26, 36, 61, and 75, but more especially with Fig. 56 already referred to, from Taplow. This last has no more precise history, but the most prolific deposit there is the gravel of the 50 ft. terrace of the Thames (visible from the railway station), and the implement looks as though it came from brickearth. There can be little hesitation in assigning it to the period of Le Moustier, but difficulties begin when the significance of its fellow from the Graves comes under discussion. On typo-

Archæologia, LXIII., 115, Fig. 13.

logical grounds they are not contemporary; but ours seems as closely allied to the Taplow type as the latter is to the well-known "point" of Le Moustier.* In the British Museum is a specimen from Le Moustier cavern that serves to link up the "point" and the triangular implement of Taplow; it is 3·4 in. long, and 2·6 in. wide, with both faces flaked convex, one side edge more curved than the other, and the bulb and platform left untrimmed in the centre of the base. The removal of this would produce an implement almost identical with Fig. 56; and a careful examination reveals a very close connection between the latter and Fig. 55. Common to both are the pointed top (or butt, if the celt-form is insisted upon), the unequally curved side-edges (the straighter line being on the left of both figures), the sharp point at the lower end of the left side, and the rounded angle below the right side-edge; the sharp almost straight cutting-edge below; the back trimmed flat and the front convex. Their lengths are identical, their maximum thickness the same, and the difference in their maximum widths 0·8 in. Both are sharp and unrolled and have on the right of the front that peculiar scaling that is characteristic of Le Moustier and is well exemplified in the large chopper (Fig. 64) that might have come from the classic cavern. The differences are unimportant, the chief being the occurrence of the greatest thickness in the Graves specimen towards the left side, not central, but this does not impair the similarity of their longitudinal sections. To those not familiar with the variety of patina from the Graves, where the majority of the worked flints must be contemporary, the difference in colour may be surprising; but this is an unessential difference, the mottled indigo and white of the Taplow piece being familiar in late Drift deposits (brickearth, etc.), while the blue-black and blue-white faces of the other are now seen to be due to the accident of position in the floor material, the upper face being normally the more changed from the original black.

Fig. 56.—Patinated implement from Taplow, top and end views ($\frac{2}{3}$) B.M.

The above coincidences might be accepted and yet the conclusions drawn from them might be quite at variance. The only

* Especially those with surface-flaking, cf. Schmidt, *Die diluviale Vorzeit Deutschlands*, 127, Fig. 44 (3.3 in. long).

suggestion made here is that the celt is a narrow form of the triangular hand-axe, its birth and parentage being revealed by the excavations at Grime's Graves. The determination of this point would in itself be no mean achievement.

FIG. 57.—This would pass as a rough celt, with both faces flaked and a sharp butt (narrower end). The patina is white, with a patch of an original black surface (see under Figs. 34, 35) that seems to resist ordinary patination, but is occasionally spotted with white or blue.

Fig. 57.—Celt-like implement with sharp butt, top and side views ($\frac{2}{3}$) N.M.

The importance of floor 3 may be measured by the number of specimens chosen for illustration—twelve from the top level (C) and five from the middle level (B) above the rubble, whereas only one worked specimen was collected from the lowest level (A) on the sand that covers the whole Grime's Graves area, and may be decalcified boulder-clay. This solitary specimen is however of some significance, and comes from the "top sand in rubble." It is 6·5 in. long and may be described as a tortoise-core like Fig. 37, with the upper face left unfinished, with crust, that is, not finally prepared for detaching the flake-implement. The faces are white and bluish white, and this inequality of patina was very conspicuous at the top level (C), where over 500 specimens of human work were collected. The combinations of black and dark blue on the one hand and light blue and white on the other were nearly equal in number.

Implements recalling the leading Drift types were numerous and included triangles, ovates and discs, but many from this horizon had one flat face, a feature that should belong to a culture based on Drift forms, but capable of producing new varieties. A good example is in the form of an isosceles triangle (B.M.), 3·5 in. long, with complete white patina, and thickest near the butt; and a trapezoidal specimen (B.M.), ½ in. longer but very similar in other respects, came from this floor. The flat face also occurs on a shield-shaped implement (B.M.) with spur in the middle of the broad end very like Fig. 71 from the same horizon, even to the bevel behind the spurred end; also on a triangular implement with notch on the left of the apex (B.M.), and on an implement 3·3 in. long resembling Fig. 21 and to a less extent Fig. 33. The occurrence of this feature on the segmental tool has been repeatedly noticed, and this horizon produced specimens with and without the hinge-fracture along one (in this case the convex) edge of the base (B.M., N.M.). The type with cutting-edge shaped like the letter U and often erroneously called the end of a celt * was also found with one flat face (B.M.), measuring 4·5 by 3·5 in., with traces of vermicular patination; another (I.M.) has almost a square thin end; but doubly convex specimens of this or the D outline † were common.

The scrapers naturally have a flat or slightly concave base, and there were several varieties of this implement. A notable specimen (I.M.) is a good representative of the type (Fig. 71) which occurs at High Lodge as well as on floors 2 and 12: it is intermediate between the end and side-scraper (*grattoir* and *racloir*), and the lengths of these three from the Graves are roughly 3, 4, and 5 in. A broad blade-scraper (B.M.), 2·5 in. long with longitudinal ridge not central is a rarity from the Graves; as is also a thin blue and black specimen (B.M.) 4·3 in. long, in the style of the later Cave-deposits. A blue-grey end-scraper (B.M.), 3·8 in. long, is a three-sided prism, with steep fluting at the end and on the left side of the fluted end a spur. This excrescence was evidently found useful, as it occurs on a round scraper from this horizon (C.A.M.) and sometimes on the "dolphin" plane (Fig. 31) which is well represented here. This spur is accentuated by lateral notches on the base of a cone (B.M.), measuring 2·4 in. across, and occurs on more or less

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* Examples also from flint-mine on Massingham Heath, Norfolk, 19 miles N. of the Graves (*Archæologia*, LXIII., 140).

† Dr. Schmidt may use the term in a slightly different sense, but mentions such a type under the Räuberhohle, near Regensburg (Ratisbon), Bavaria (*Die diluviale Vorzeit Deutschlands*, p. 32 and pl. XI., Fig. 9), the date of the cave-deposit being mainly transition Le Moustier–Aurignac. He states that in form and style of chipping the specimen illustrated approaches Western European types of the transition period from La Quina (latest Le Moustier) to Aurignac; and implies that, though only occurring at this one spot in Germany, it is typical of the Abri Audi culture in France (his p. 153). On his Plate XI. are represented other forms that might be matched from the Graves: a segmental tool (apparently), Fig. 7; a disc with spur, Fig. 6; and a rib-bone with transverse marks, Fig. 11, the last being frequent in the closing phase of Le Moustier culture, and known as a *Knochenunterlage* or *compresseur*.

related forms at Abri Audi * in the Dordogne and Stollhofen,† near Herzogenburg, south of the Danube, in Lower Austria.

A waisted plane (B.M.), 3·5 in. long,‡ leads on to the carinated form of which good examples came to light. One (B.M.) answers to the description better than most, recalling the outline of a boat (*cf.* floor 3c): it measures 3·1 in., has a nose with lateral notches at one end, and a black-to-white patina. Another form that would perhaps be included under that heading § by some authorities, has been compared to a caterpillar: it generally has a flattish upper face with crust, steep flaking all round and a broader flat base, the edge being sometimes engrailed like the more conical lumps that were found in some quantity at this horizon. The length is generally 4·5 in. Segmental tools and flakes with facetted butts were abundant, and there were over thirty heavy lumps roughly flaked into oval form, perhaps roughed-out hand-axes. The square core with alternate flaking (as Fig. 60) was fairly common, and there were about a dozen nodules used as hammer-stones.

Among the rarities were two quadrant choppers (one B.M., *cf.* floors 11 and 13) with the usual zigzag cutting-edge; a cone with curved nose much like one (B.M.) from gravel at Shortheath near Farnham, Surrey; ‖ two slender blades or splinters much smaller than the average—one is 2·1 in. long (B.M.) and the other 2·7 in. used as a scraper at the bulbar end. A tribrach ¶ or implement with three incurved sides, 2·8 in. long, must be mentioned: it has a flat face and worked notches in two of the sides; and an implement (B.M.), 3·6 in. long, resembling the hand-axe but with a sharp sloping butt (not blunt as Fig. 70), might be passed over as an accident were it not for close parallels from Pit 2 (B.M.) and Cissbury (Brighton Museum). Two flaked lumps (B.M.) were selected as specimens of "gloss" in dots or splashes, but no explanation of its occurrence here or (much more abundantly) at Knowle Farm Quarry, Savernake, can be attempted in this place.

There were a few heavy lumps that had been roughly flaked into the form of tortoise-cores, but were not quite regular. More striking were the numerous examples of the *dos abattu*, Dr. Sturge's forms 2, 3, and 4 being well represented (*Proc.*, i., 218), a splendid example (B.M.) of form 2 measuring 6·2 in. and closely resembling Fig. 63 from the horizon below. Another type connected with the French caves is a *double* steep-faced sub-conical scraper (B.M.): it measures 2½ in. across, and the fluting is effected

* *Rev. de l'Éc. d Anth. de Paris*, 1909, 323, Fig. 155, No. 11 (*disque à pointe*): for the Abri Audi point, see under Fig. 27.

† *Jahrbuch für Altertumskunde*. III., 157, Fig. 2a.

‡ Smaller and less regular than Figs. 38 and 39, *Archæologia*, LXIII., 153.

§ For varieties of the *grattoir caréné*, see *Compte-rendu* of Monaco Congress (1906), I., 337.

‖ Figured in *Proc. Geol. Assoc.*, XXIV. (1913), 192: presented by Mr. Henry Bury, and found 150 ft. above the Wey.

¶ A term used by Sir John Evans (*Stone Impts.*, 2nd edn., p. 78).

from two rounded platforms that serve as the bases of alternate planes. There are in the British Museum specimens from the Dordogne, and most surprising of all one from Ellon, Aberdeenshire. It is difficult to illustrate or describe this form, but inspection of a number would dispel the theory that they are cores, and their occurrence in the Dordogne caves should remove the Neolithic stigma from British specimens.

It was in floor 3c that the nearest approach was made to the "point" of Le Moustier, one specimen in particular 3·3 in. long being suggestive of what is the commonest form in that cavern. Its much facetted butt brings it into relation with the Northfleet or Levallois series, and there were many flakes on this horizon with the butt so treated, more or less successful as flake-implements; nor should one overlook a plunging-flake, 7·7 in. long, just like those from floor 12 (Fig. 72) and Northfleet (Fig. 73), which was meant for a flake-implement, but on being detached from the tortoise-core, went too deep at the end opposite the butt.

FLOOR 3b (See p. 101).

FIG. 58.—A black triangular or heart-shaped hand-axe with perfectly fresh edges, and crust on about one-third of the more convex face. It has a cutting-edge all round and, in spite of an ill-directed blow on the front, is of good, bold workmanship; and

Fig. 58.—Cordate hand-axe, front and back views (½) B.M.

would be accepted at its face value, at any rate till its origin was disclosed. It was found in rubble on the middle bed of this floor (3B), and is in the same condition as specimens found at the bottom of the pits and in the galleries; that is, absolutely unchanged.

FIG. 59.—An implement of excellent workmanship but peculiar form, black on the underface which is slightly concave and a little

trimmed; and all shades from black to white with crust on the front. The sides are curved inwards, and a fairly regular edge passes all the way round. It is a complete implement, the front being flaked all over with special care; but its mode of use is not clear. The same might be said of a large number of "hand-axes" from the Drift with the cutting-edge all round; but their significance

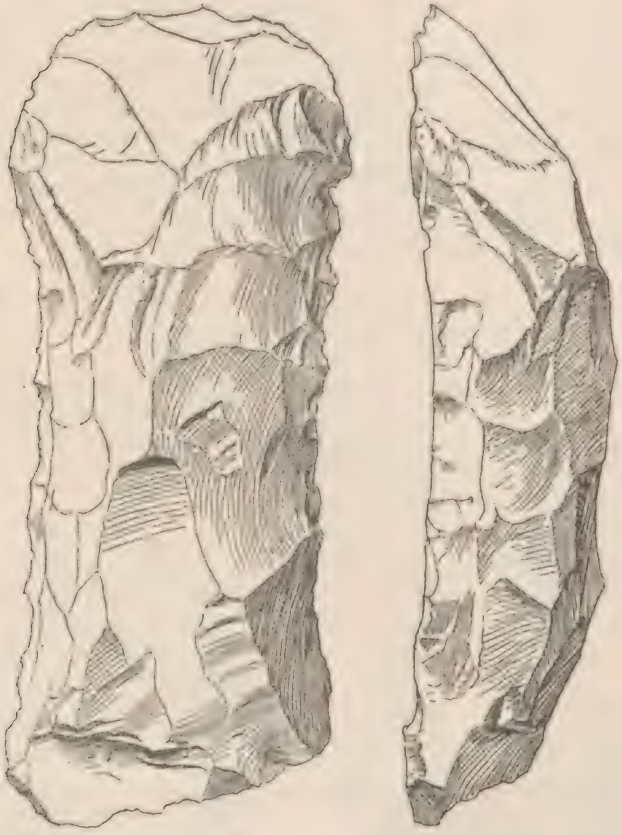

Fig. 59.—Implement with incurved sides, top and side views ($\frac{2}{3}$) B.M.

is not diminished by our ignorance of their use. The only similar implement from the site was found in the black band (layer 3) of Pit 2, and measures 5·4 in. It has approximately the same outline, with concave plain face, but is altogether thinner, and less convex in front.

FIG. 60.—A typical specimen but not the finest of a series that may be nothing but cores, but are roughly of the same size and shape, approaching a square and proportionately thin, with long flakes detached from both faces but in directions at right angles to

one another. The present example is blue-grey on the face that is flaked all over, the other being blackish, with an old natural surface at one side; but most are flaked all over both faces, sometimes with

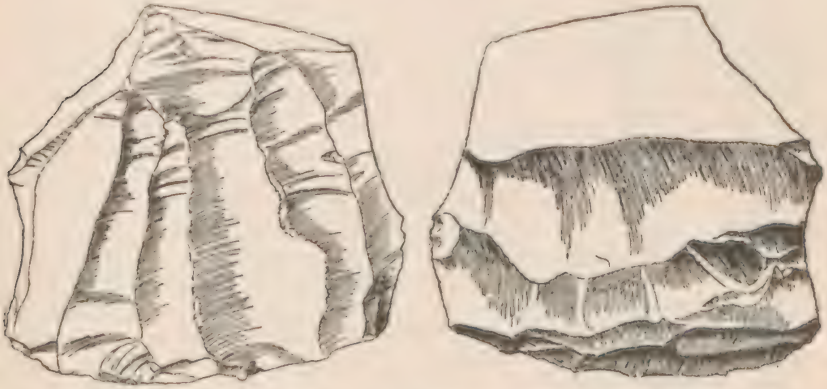

Fig. 60.—Flint flaked at right angles on the two faces, front and back views ($\frac{1}{2}$) B.M.

great regularity, but always on a large scale. Canon Greenwell found a good specimen (B.M.) in his pit at Grime's Graves, at a depth of 24 ft.

FIG. 61.—One of the most interesting "celts" found, inasmuch as its butt is squarish, not pointed like the rest (Figs. 26, 36, 55, and 75). The back is black and fresh looking, the front a bluish-

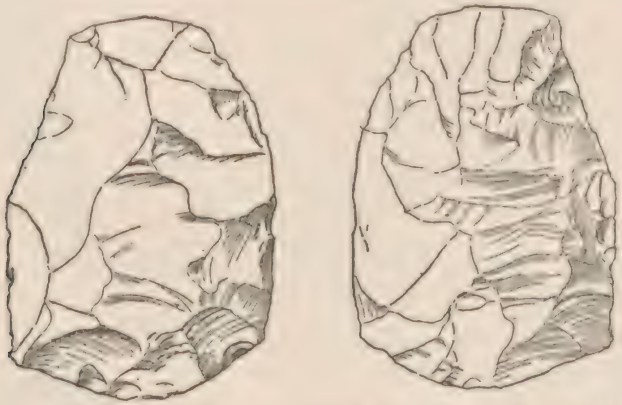

Fig. 61.—Celt-like implement with broad butt, front and back views ($\frac{2}{3}$) C.A.M.

white, and the broad cutting-edge rounded. This variety is known from Cissbury, and something very like it occurs in the gravels, as for instance one from Partridge Hill in Reading Museum; hence it is not necessary to suppose a pointed butt has been broken off.

Fig. 62.—Blade-scraper, top view with end and facetted butt ($\frac{2}{3}$) B.M.

FIG. 62.—This long blade-scraper is a rarity from the Graves and an important piece of evidence. In the late Cave-period and indeed from Aurignac times onwards, the blade, or flake with dorsal rib or ribs and roughly parallel side-edges, is the foundation of most implements, but they are generally smaller than the specimen illustrated, which has the under-face plain with bulb, signs of use (undercutting) at the top end, and at the butt the familiar facetting seen on the Northfleet flakes. Unless that feature is another mysterious revival, this *grattoir sur lame* must be one of the earliest of its kind. There are slight traces of use on the side-edges, but they are not dressed to blunt the edge as in full Aurignac times.

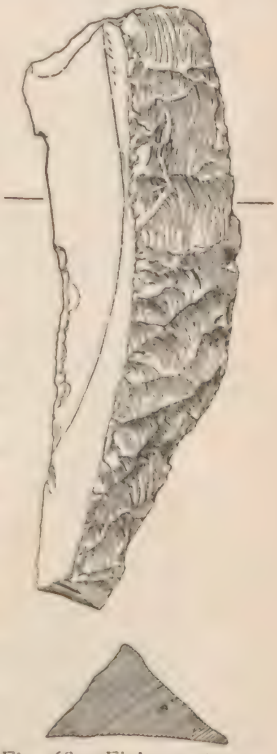

Fig. 63.—Flake with triangular section and battered back ($\frac{2}{3}$) B.M.

FIG. 63.—A fine example of the "battered back" (*dos abattu*) on a large scale. It is of triangular section, patinated white all over, with one face flaked transversely throughout its length; the other faces quite plain, and the knife-edge opposite the battered back shewing signs of use. This came from rubble on floor 3B and seems a clear case of use as a knife, but the exact purpose of other specimens is sometimes hard to determine. It belongs to Dr. Sturge's division 2 of the large class of worked flakes included under the name,* and was by no means the only example of this variety found at the Graves; another measuring 6·1 in. in length (B.M.) was even found in the same deposit. For another variety, see Fig. 20.

Proceedings, Vol. I., p. 218.

From the second (B) level of floor 3 about 150 worked flints were collected, and there was a large proportion of black or blue-black, hardly any pieces being white on both faces, and very few white even on one face. The contrast with the upper level (C) is very striking, and in this case at least the amount of patina was in inverse ratio to the depth from the surface, the upper face being normally the more patinated. The President made some careful observations on this point, and the discovery of this rule at the Graves should have far-reaching results.

There were a few sub-triangular hand-axes between 4 and 5 in. long; a specimen with one flat face has been referred to (p. 158), and a large disc (C.A.M.), 4·7 in. across, has crust on a blunted part of the edge. An enormous flake, 8 in. long, has a small butt showing facets, and a few smaller flakes have the same characteristic; while the Northfleet industry is further suggested by a lump of oval plan, 5 in. by 5 in., with a maximum thickness of 3 in. It is conical and crusted below as usual, and the upper face is spoilt by crusted hollows which would have left holes in the flake-implement. This was ample reason for leaving this and the illustrated specimen (Fig. 37) unstruck.

Several of the leading Grime's Graves types were duly represented; such as the "dolphin," by two grey specimens perhaps of wallstone (one I.M.), measuring exactly 5 inches; and the square core with alternate flaking on the two faces (as Fig. 60), by several specimens of various sizes. Isolated examples were no less typical, such as a cone (B.M.) with engrailed base and spur in centre flanked by notches; a carinated plane (B.M.), 3·7 in. long and exceptionally broad, black, blue and white, with both ends blunt; a black round scraper (B.M.), 3·3 in. long, with both faces flat and the butt trimmed along one edge; and a long narrow celt almost of Cissbury type, with one face flatter and the broad end rather steep.

There was a quartzite hammer damaged by fire; a fine segmental tool, 5 in. long, with both faces convex; several with one face flat; and a semicircular slab (B.M.), 4 in. long, with black and blue-white faces and bulb trimmed away at the top, resembling in most points a smaller specimen (H.M.G.) from floor 7, both being carefully trimmed round the curve.

Implements of crescent form are rare, and a small one (B.M.), 3·8 in. long, of the same general form as one described from floor 2 (N.M.), has crust on the concave edge, a zigzag cutting-edge and both ends worn smooth by use. A cognate implement (B.M.) of elongated kidney-shape, 6·1 in. long, has one face trimmed flat, the edge trimmed all round, and a broad worked notch in the middle of the concave edge. There are illustrations of what seem to be parallels from Les Rebières, Dordogne (Le Moustier date) in *Archives Suisses d'Anthropologie générale*, 1914, 49, Fig. 3, Nos. 1, 2; and *Compte-rendu* of Monaco Congress (1906), i., 299, Fig. 69.

The floor at this level also produced an example (B.M.) of the "caterpillar" type already referred to (p. 182): it has thick floor-

stone crust on the top, a steep edge all round and a length of 5·1 in., somewhat tapering. There were also fair examples of the cone and toe-cap (as Fig. 74), one of the latter being 4·7 in. long with squarish top end (like one from Pit 1, C.A.M.); and another had the butt of triangular section, and the cutting-edge not in the central plane. The tendency to squareness is also seen on an end-scraper from this horizon, length 3·4 in.

FLOOR 4 (See p. 104).

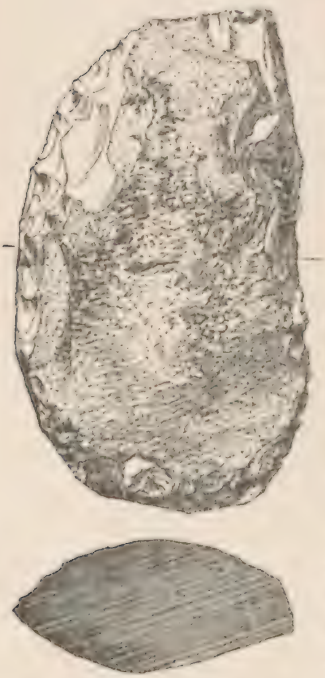

Fig. 64.—Heavy chopper, with section ($\frac{1}{3}$) B.M.

FIG. 64.—One of the principal treasures from the Graves, in the shape of a chopper that can be matched exactly from Le Moustier itself, and belongs to a series that is not known to date from any other period. One face is more convex than the other, the front being almost covered with thin crust, and the flatter back plain except for slight trimming. The thick back is adapted to the hand by flaking, and the opposite cutting edge is chipped on the upper (crusted) face only, the under-cutting or step-flaking being as characteristic and unmistakable as the clean under-surface along the edge.* There are a few glossy spots that are generally looked upon as a sure sign of antiquity (compare p. 182), and its remarkable length (8 in.) and weight are in keeping with another specimen of Le Moustier facies, the tortoise-core from Pit 2. One of the leading features of the earliest Cave period is the *racloir* edge, the face that came in contact with the material in working being unaffected, usually the bulbar face of the flake. Many of the heavy choppers from Le Moustier are trimmed on both sides of the cutting-edge, as often in the Drift; but the chopper *par excellence* from that famous cavern is exactly the form now recovered from Grime's Graves. It comes from a floor, not from a pit, but does not prove that the surface finds there are earlier or later than those in the pits; and the tortoise-core, not to mention other Le Moustier forms (pp. 197, 201), is available to correct any misapprehension on this point.

*These features are well seen in a specimen from Highbury New Park figured by Sir John Evans (*Stone Impts.*, 2nd edn., 585, Fig. 453). For examples from Le Moustier itself, see *Reliquiæ Aquitanicæ*, Plates XXXVIII, XXXIX.

FIG. 65.—Steep-ended plane or end-scraper, under-face plain but with bulb trimmed. The flaking is bold, without any trace of fluting, and the right edge has secondary work on both faces. The upper face is patinated white, contrasting with a patch of original

Fig. 65.—Steep-ended plane, top and side views ($\frac{2}{3}$) C.A.M.

black due to a fracture in the material before it left the chalk (*cf.* Fig. 34). The cross-section is triangular near the head and trapezoidal near the butt.

FIG. 66.—An implement that is celt-like in a sense, but would be more easily recognised if it had not the appearance of being twisted, the two halves being roughly in planes at right angles. The butt is rudely shaped but the edges elsewhere are trimmed, with a minimum of flaking on the under-face of the rounded cutting-edge, the upper edge being rather bevelled. It is patinated white with sepia markings like those on Fig. 67.

Floor 4 like the others contained specimens of the hand-axe, one sub-triangular with one face plain and the other almost conical; another with steep sides flaked from the two faces alternately, bluish white with patches of old black surface; an ovate with the flat face trimmed and a butt of triangular section; and another of the same outline made from a flake, thickest near one side. Of three noticeable segmental tools one was of small size with one flat face and binge-fracture on base; another had a good cutting-edge and the bulb at one end of the base; and the third was again one-faced, and

had crust on the base, showing that it was a complete implement. A heavy lump of the same class measured 6·5 in. in length.

A good flat core (B.M.) is a still better example of the alternate flaking of the two faces than Fig. 60: it is 4 in. square, with one face bluish, the other decayed white, with a patch destroyed superficially. Another example of the type was much thicker, and the type occurs at Cissbury (British Museum). There were three fluted lumps forming part of a cone but very thin, and a fine example of the fluted plane, tapering away from the scraper-end: this form is nearly related to the *grattoir museau* and the *burin busqué* * and seems to form a link between them: it is 3·5 in. long. A prismatic flake, 3·3 in. long, had the end steep and fluted; another was a complete prismatic tool (as Fig. 48) with the point unused, and a third had the under-face trimmed flat, instead of the usual plain fracture. A large variety of the end-scraper or plane measured 6·5 in. in length and had an almost square cross-section, with crust on the upper face; and a fair example of the Levallois or Northfleet flake with facetted butt was 5·5 in. long. An exceptionally delicate flake, flat and triangular (B.M.), is thickest at the apex where the point is accentuated by two slight flanking notches.† There is secondary work on the base and sides, and the back is plain, the length being only 1¾ in. Somewhat of a rarity from the Graves is a lump (B.M.) not only stained with iron but in places incrusted with the mineral in a granular form. A steep-ended and somewhat carinated plane (I.M.), with dappled crust on the top and a flattish base, is 4·1 in. long and resembles one from floor 13 (N.M.).

Fig. 66.—Implement with celt-like end, top and side views (½) B.M.

* *Revue de l'École d'Anthrop. de Paris*, 1906, 407; *cf.* especially Fig. 133, No. 34.

† Much the same form occurred at Abri Audi (*Actes de la Société Linnéenne de Bordeaux*, LXII., Plates XIX., XXII., and especially XXIII., Fig. 3).

FLOOR 5 (See p. 104).

FIG. 67.—A finely shaped ovate implement with one face trimmed flat; the other rather conical, but apex not central. Patch of original black (*cf.* Figs. 34 and 51), and the rest white with sepia

Fig. 67.—Ovate implement with flat face, top and side views ($\frac{2}{3}$) C.A.M.

markings due to manganese. The flat face suggests Le Moustier period, and the thick side its use as a chopper, but it is probably a late form of the hand-axe, of which the true purpose is unknown.

Floor 5 was one of the minor deposits, only about thirty specimens having been recovered with signs of human work. The Northfleet industry was represented by half a Levallois flake with finely facetted butt, and an implement that came off short from the tortoise-core (*cf. Archæologia*, LXII., 529, Pl. LXXIV., Fig. 4). A large flake 4·2 in. across has a spur in the centre of the steep scraping-edge; and a flake of triangular section (B.M.) 5 in. long has each edge battered (*dos abattu*) in such a manner as to show only on one side of each bevel: this is a variety of Dr. Sturge's type No. 1. What must rank as a prismatic tool (B.M.) is rather shoe-shaped with squared fore-end, the sides carefully dressed and the patina white with sepia markings; length $2\frac{3}{4}$ in. There was a heavy blade-scraper just like one from floor 7, 4 in. long, and an example of the rare round-scraper (B.M.), the edge steep in places and sepia markings on one face, diameter 2·5 in. Several of the other flints seemed to be rough attempts at the ordinary types, such as the "dolphin," cone, segmental tool, hand-axe and chopper, one of the hand-axes being a good example of contrasted patinas, white and blue-black on opposite faces.

FLOOR 6 (See p. 104).

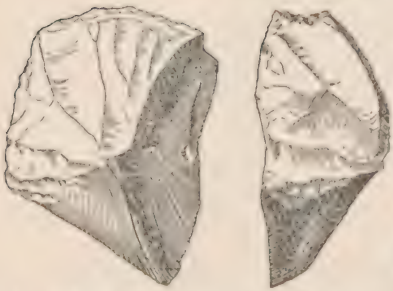

Fig. 68.—Fluted end-scraper, top and side views ($\frac{2}{3}$) B.M.

FIG. 68.—This specimen is as fine an example of the peculiar Aurignac style as one could expect, and could be easily matched in collections from the French caves, but that such work is not confined to France is shewn by the well-known series from the loess of Krems, on the Danube 40 miles above Vienna.* It consists of a round-headed scraper with steep fluting and considerable undercutting (due to prolonged use or repeated sharpening), the butt being on the slope and terminating on one edge in a point. The side-edges are really parallel, hence it must rank as a blade-scraper, but the face is regularly domed and is exceptionally thick at the centre. It is white all over, except for a small patch of buff crust at the side of the head.

FLOOR 7 (See p. 104).

FIG. 69.—A good example of the one-faced segmental tool or "tea-cosy" type, though the flaking is somewhat coarser than

Fig. 69.—Segmental tool with flat face, front and side views ($\frac{2}{3}$) B.M.

usual. Its chief merit is the thick crust covering the entire base, on which it stands firm, this and several other specimens of the

* Strobl and Obermaier, *Jahrbuch für Altertumskunde*, iii. (1909), 129 and Plates.

type (as one from the Graves found by Canon Greenwell and figured in *Archæologia*, LXIII, 113, Fig. 3; others in Brighton Museum from Cissbury) correcting the erroneous belief that this is not a complete implement but only the broken end of a celt. The cutting-edge follows an approximate semicircle; but in the illustrated specimen, for a little distance above the base at one side, the edge is replaced by a facet. All stages from the bold zigzag to the even edge are represented from the Graves and Cissbury, and the segmental tool seems to merge into the wedge-shaped chopper on the one hand and the "toe-cap" form on the other. The latter is noticed under Fig. 74, and an imposing example of the former from the well-known Le Moustier site of High Lodge is in Dr. Sturge's collection. There is little doubt that the identical industries of Northfleet and Montières (near Amiens) are of Le Moustier date, but the segmental tool has hardly been recognised as a type, and few discoveries giving a clue to its date or range have been recorded. A good specimen from Les Eyzies (B.M.) with cave-breccia adhering has been already published in this connection (*Archæologia*, LXIII., 132, Fig. 29: Geneva Congress, *Compte-rendu*, Vol. I., 409), and two thinner examples, more of the horse-shoe form, are in the collection of Mr. Montgomerie Bell, from a prolific deposit of brickearth at Brice's Cross, Limpsfield, Surrey, on the edge of the Greensand escarpment. Canon Greenwell found the duplicate of Fig. 69 at the Graves; it is now in the British Museum, and three views of it are given in *Archæologia*, LXIII., p. 113, Fig. 3.

Floor 7 was remarkable for its six flat square cores with alternate long flaking on the two faces (as Fig. 60). There was one thin segmental tool (H.M.G.) carefully trimmed round the edge, 3·3 in. long, with a rudimentary hinge along one side of the base. End-scrapers or planes included two (one C.A.M.) of the "dolphin" type (*cf.* Fig. 31); one with additional scraping-edge along the side and a powdery white surface; and another on a heavy blade like one from floor 5. A "cone" approached the spherical form with old black surface at the back (opposite the best part of the curved edge); and there were also hammer-stones and a small prismatic tool with dressed sides and a steep end.

FLOOR 11 (See p. 105).

The peculiar dappled crust described above (p 170) was well represented on floor 11, but the types were not abundant. There were a few rude hand-axes of various outlines; and a large flake-implement of Northfleet type with slightly facetted butt, another being thickest in the centre. One steep-ended plane had a triangular section (as on floor 3c); and a triangular flake was "nosed" at each angle. Two very large blocks had zigzag cutting-edges as if for use as choppers, and mention must be made of a white quadrant chopper, that is, a thick tool with two broad sides at right angles to one another, the cutting-edge being more or less rounded. This is no accidental form, for it occurred more than once at Cissbury (Dr.

Sturge's collection and B.M.); in the Northfleet deposit,* and also on the Palæolithic floor in brickearth under a contorted Drift at Round Green, Herts., discovered by Mr. Worthington Smith (B.M.). Two sub-conical lumps of oval plan have an engrailed edge round the flat face which may be due to flaking from a core, but is more probably intentional (*cf.* Peppard, *Arch. Journ.*, LXX., 61, Fig. 24). Others were found on floor 12.

FLOOR 12 (See p. 105).

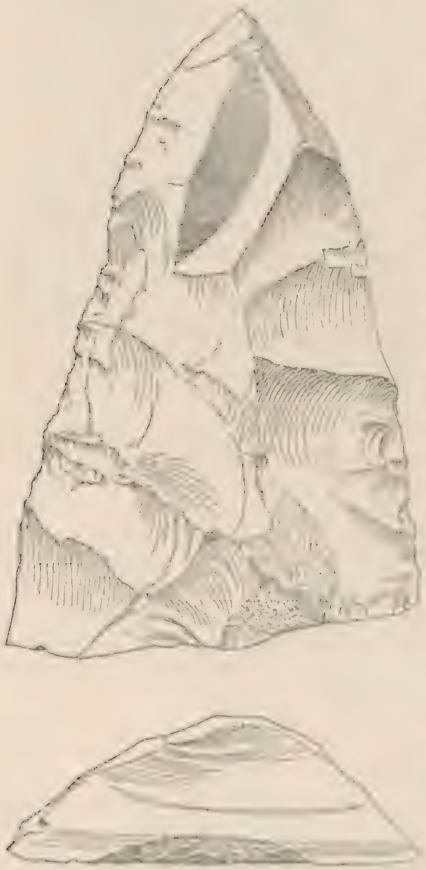

Fig. 70.—Point with flat face and false hinge, top and end views ($\frac{2}{3}$) B.M.

FIG. 70.—An exceptional implement that would at first sight be taken for a fragment, but is complete† and has the sloping butt frequently found on the "toe-cap" form (as Fig. 74). It is triangular in plan, with the back trimmed quite flat and of blue-and-white patina shading into black. The front is regular, domed and flaked all over except for a patch of crust on the right of the point, the patina being uniformly white. The side-edges are carefully dressed, on the front face only, and the base agrees with several segmentals from the site in having one edge (in this case the straight edge) battered along the middle, as if blunted intentionally. The presence of a hinge-fracture in this position on several examples (like that from Coombe-rock at Northfleet, *Archæologia*, LXIII., 131, Fig. 28) suggests that an attempt was made to secure the rounded fracture by a single blow, but when that failed (as it must often have done) the sharp edge was reduced by battering. This was no doubt due to the manner in which the implement was held.

* A large specimen from Baker's Hole (Southfleet pit) has been presented to the British Museum by the President.

† Dr. Sturge has another from the same parish of Weeting, ¼-in. longer, with the same sloping butt, but of "chalcedonic" flint. A Cissbury specimen with sloping base and false hinge is in Brighton Museum.

FIG. 71.—An implement of some significance, as its counterpart, sloping the other way, is to be seen in Dr. Sturge's collection from the Le Moustier station of High Lodge, Mildenhall.

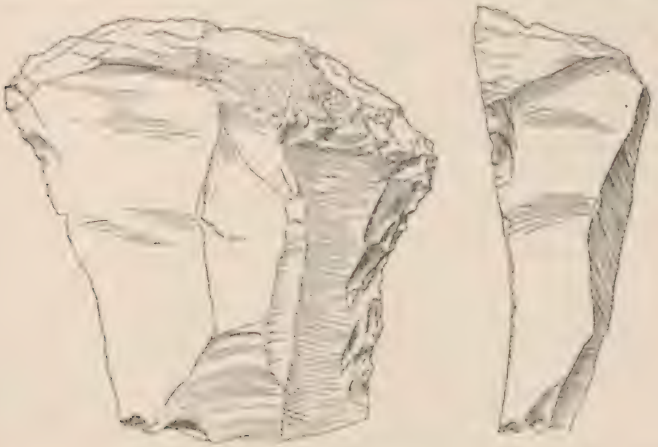

Fig. 71.—Thick flake with curved scraping-edge, top and side views ($\frac{2}{3}$) B.M.

Fig. 72.—Plunging flake from a core, back and side views ($\frac{1}{2}$) B.M.

The sloping edge is steeply bevelled for scraping and the implement is made out of a heavy flake, but there is a much larger example, exactly of the same form, that came from floor 2 and measures 5 in. in length, against 3·2 in. A third from floor 3c (I.M.) measures 4 in., with black to white patina. The scraper here figured has the darker patina on the flat back, and the right edge has been trimmed, no doubt for convenience in holding. It seems to be a form intermediate between the side-scraper (*racloir*) and the end-scraper (*grattoir*), the latter being generally on blades (with parallel sides) in the later stages of the Cave period.

FIG. 72.—An unexpected link with the Northfleet industry consists of a plunging flake, 7·5 in. long,* the top face black and the other light blue. The bulb is partly trimmed away, and the blade is 1½ in. broad near the butt, expanding to 3 in. at the other end, which is also much thicker. This is in a sense an accidental form being an unsuccessful attempt at a one-faced hand-axe; but so far as is known, it is an accident that occurred only at one period, and its main horizon in the Somme valley is the base of the *ergeron* or later loess; that is, lower Le Moustier.† The specimen illustrated (Fig. 73) from the Northfleet floor (*Archæologia*, LXII., 523, Fig. 2) is an exact parallel, though 1 in. shorter, and it is difficult to with-

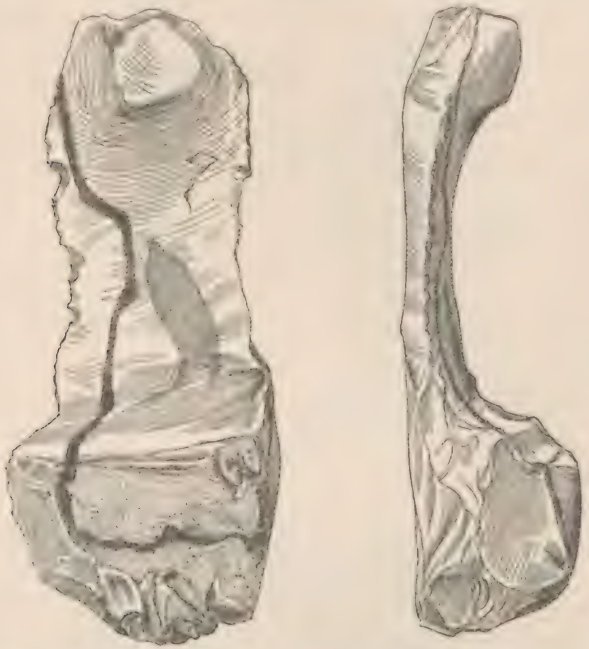

Fig. 73.—Plunging flake from Northfleet, Kent, back and side views (½) B.M. (Reproduced by permission from *Archæologia*).

* Another, 7·7 in. long, on floor 3c (p. 183).
†Commont, *Les hommes contemporains du renne* (1914), 63, Fig. 13.

stand the evidence of the tortoise-core (Fig. 37), the short flake (floor 5), the plunging flake here described, and the many flake-implements with facetted butts from nearly every site examined at the Graves. All these are features of one industry that has come to light on the banks of the Thames and the Somme, and seem to have lasted through the whole period of Le Moustier.

Fig. 74.—Thin implement of toe-cap form, front and end views (⅔) B.M.

FIG. 74.—A thin specimen of a type that may be considered common from the Graves, and has above been compared to the toe-cap of a shoe. The present example has the characteristic sloping butt, without either the hinge-fracture or battering in imitation of it. The faces are nearly flat, both blue-white but one darker than the other as usual; and except at the base, the edge is fine secondary chipping all round on both faces. To show that this is no accidental form, it is sufficient to refer to one about ¼ in. longer from Pit 1 (C.A.M.), which is battered in the centre of one edge of the sloping base; another from the black band of Pit 2 (N.M.) with one face trimmed flat, and another, from the companion site of Cissbury, Sussex, illustrated in *Archæologia*, LXIII., 127, Fig. 21.

The worked flints from floor 12 were mostly white, but there were several patches of old black surface (p. 162), sometimes spotted with incipient bulbs of percussion that have invited patination. There were five hand-axes, one measuring 6 in. in length (C.A.M.), with one face trimmed flat; also two side-scrapers (*racloirs*) measuring 3·1 in. (B.M.) and 3·6 in. (C.A.M.), and corresponding to the type of Le Moustier.

A fine wedge-shaped chopper (B.M.) measuring 4·2 in. in length has one vermiculated blue and white face, marking a stage in the growth of patina. A cone (B.M.), 3·3 in. high and the same across the concave base, has a spur in the middle of the blue and white front, the neglected back having the old black surface. A crescentic implement, 4·5 in. long has the convex edge partly worked, and is thickest along the median ridge. There were also a thick disc and an engrailed * ovate implement with one flat face, 5½ in. long; plain cones; several large flakes with floorstone crust and facetted butts; good examples of the square core with alternate

* This condition of the edge may mark the unfinished scraper, or one that has not been rounded by use; for an Aurignac example, see *Revue de l'École d'Anth. de Paris*, 1907, 423, Fig. 186, No. 18.

flaking (as Fig. 60); a quartzite hammerstone (C.A.M.), and a "dolphin" plane (N.M.) 3·5 in. long, pairing with that from layer 2 of Pit 2 (Fig. 31).

FLOOR 13 (See p. 105).

FIG. 75.—Another example of the celt-like implement that is a crucial type at Grime's Graves. Made from a flake, it is sub-triangular in plan and has the characteristic bulging curve on the side. The butt is trimmed on both faces to a point, and the cutting-edge is as usual angular at one end and rounded at the other. One lateral edge is zigzag, the other worked or used on one face only in the style of Le Moustier, a combination noticed also in Fig. 39. The cutting-edge has a thin transverse flake removed (like a *tranchet*) * from one face and is trimmed in more usual fashion on the other. Another specimen very similiar (B.M.), measuring 3·8 in., comes from floor 3c, with a thicker edge all round, blue-black, and trimming on the flatter back; and comparison may be made with one of Le Moustier period figured in Forrer's *Urgeschichte des Europäers*, p. 57, pl. 14, Fig. 6.

Fig. 75.—Celt-like implement with pointed butt ($\frac{2}{3}$) N.M.

Floor 13 was very like floor 12 in its flint products, which numbered about fifty, mostly large, including all shades of patina. A large sub-ovate hand-axe (I.M.), 5 in. long, is made from a flake, with the bulb trimmed away on the flat face; and another flaked on both faces white and dove-colour respectively, is 4·9 in. long (N.M.). A rough specimen (N.M.), 5·2 in. long, has powdery white and old black patches on one face, while the other is white and bluish. Two of the segmental tools—one without a flat base (Mrs. Hall) and the other with rather oblong faces—are 3·3 in. long; while another slightly longer (B.M.) has the base battered in the middle of one edge, like that from gallery 6 of Pit 2. There were several square cores with alternate flaking (as Fig. 60); a thin square implement wrongly considered the end of a celt (as Fig. 54); a thin chopper with crust on back (opposite the cutting-edge), and a quadrant chopper like that from floor 11 (p. 193). Of the imperfect implements, whether flaked on both faces or made from flakes, three seemed to be intended for hand-axes though of enormous size; and there was one rough cone with old black surface on the base. The remainder included some well-made implements, among which may be mentioned steep-nosed and broad end-scrapers, a flint hammerstone, a broad "dolphin" (as Fig. 31), and a segmental tool with

* Both faces are thus treated on a very similar specimen, 3·5 in. long, from Taranto, S. Italy, figured in *Bullettino di Paletnologia Italiana*, Ser. IV., Vol. II., p. 36.

one flat face (B.M.) and a well-made semicircular curve 3 in. in diameter. This is an exceptional specimen somewhat in the form of a horse's hoof, with blue-white convex front and black back; and what seems to be a parallel (but is not fully described) is illustrated from Abri Audi in *Actes de la Société Linnéenne de Bordeaux*, LXII., Pl. XXV., Fig. 9. Much the same implement was found by Dr. Peake in one of the Peppard pits near Henley-on-Thames (*Arch. Journ.*, LXX., 59, Fig. 22), the diameter being exactly the same. Another Peppard type from this floor is 3·5 in. long (N.M), patinated white with good engrailed edge, steep under-cut head and crust on the top (*cf. ibid*, p. 61, fig. 24), like one from floor 4 (I.M.).

SECTION 12 (See p. 123).

Fig. 76.—Side-scraper with facetted butt, front and end views ($\frac{2}{3}$) B.M.

FIG. 76.—An implement that has an interest of its own, though found in the Tumulus pit which might have been disturbed ground. Whether *in situ* or not it is certainly characteristic of Grime's Graves, though an exact parallel has not come to light on the site. It is a broad flake bluish white all over, with parallel side-edges and a top-edge at right angles, the bevel being practically the same in each case. Its cachet is given by the work on the right side-edge (front only); also by the facetted butt and prominent bulb on the reverse. These three features have frequently been noticed in this Report, and are found also in the Northfleet industry; hence in the absence of any proof that such a combination occurs at any period remote from that of Le Moustier, this point is of capital importance for fixing the horizon of Grime's Graves.

From this section also came, at a depth of $2\frac{1}{2}$ feet, a pale blue flake (B.M.) of chalcedonic quality, the only specimen found during the excavations though it is common in the neighbourhood. Iron spots occur on the ridges, and there are iron lines and white scratches elsewhere on the surface. It is sub-lustrous and, to judge by similar material broken to test this point, is only changed from the normal on and near the surface, but no explanation of the change can be given at present. It was found by the Secretary of the Society.

THE TUMULUS (See p. 106).

On the original surface under the mound were sharp black flakes and fragments, with some traces of blue patination, and the facetted butt was much in evidence, one such oval flake being 6 in.

long. At this level the best specimen was a round scraper (B.M.) 2·1 in. long, veined bluish-grey, with a thermal flake detached from the middle of the front; the edge is finely worked, and scrapers of this form are extremely rare both at Grime's Graves and Cissbury. A bluish-grey "battered back" (I.M.) of type 3, 4 in. long, also occurred, the battering having the effect of blunting the cutting-edge; also a mottled bluish plane of the dolphin type, 4·2 in. long, with a square end. Very few flints were found in the body of the mound, but a white "toe-cap," 2½ in. long, with crust on the base like a segmental tool, must be specially mentioned.

At 10 ft. were found two sub-conical lumps with steep sides and engrailed edges, a square flake of grey patina, and a black specimen of the *dos abattu* (C.A.M.), type 2 (like Fig. 63), and nearly 6 in. long.

In the upper part of the section were found two spherical flint hammerstones (one B.M.); and another specimen almost hemispherical (B.M.) might at first sight be taken for a broken hammerstone, the spaces between the flaked surfaces having the well-known bruised appearance, but the same is seen on a large flake (B.M.) that is certainly not a hammer of the ordinary type. It is incrusted and stained with iron on both faces much like certain sub-Crag specimens, and the bruised portions may be due to thermal action as this bruising is found also on flints from the Boulder-clay. The surface appears to be broken up and many incipient cones of percussion can be detected.

BEAVER PIT (See p. 122).

All the fourteen flints found in the Beaver pit were patinated white, one sub-triangular hand-axe having one face powdery (due to decay of the patinated surface) and the other hard and lustrous, with a later chip showing pale blue. Other specimens show patches of an older, slightly stained surface, and one has some dappled crust (see p. 170). One flake, 5·5 in. long, has crust on its broad back and would make a good knife: its jagged cutting-edge shows that it was used in that way. There was also a fine example of the "dolphin" plane, 5·5 in. long, found at 2½ ft.; and a hand-axe sub-conical on one face, with sepia markings (manganese, p. 170). One cone was rather fan-shaped and another, 3 in. high, had a short horizontal ridge or keel. A segmental chopper found at 2 ft. had a flaked face, and at the same level was found a lump resembling an unstruck tortoise-core, flaked all over and 5·8 in. in length. Of two hammerstones one had a very thin crust.

SURFACE FINDS.

FIG. 77.—A beautiful ovate implement, the convex front white with the under-face bluish and trimmed flat, and a cutting-edge all round. It was found on the surface by the Treasurer of the Society

during the excavations, and even though bereft of stratigraphical honours is an important addition to the flint series. It has all the appearance of a finished Northfleet implement, and was no doubt once provided with a facetted butt and prominent bulb, but both have been trimmed away; the implement represents the last stage in the process of manufacture, an earlier stage being represented by Fig. 43, without any secondary chipping. The débris of Palæolithic and modern flint-workshops may contain some identical pieces of a rough and indeterminate character; but mistakes are less likely with such elaborate specimens as this and one from the

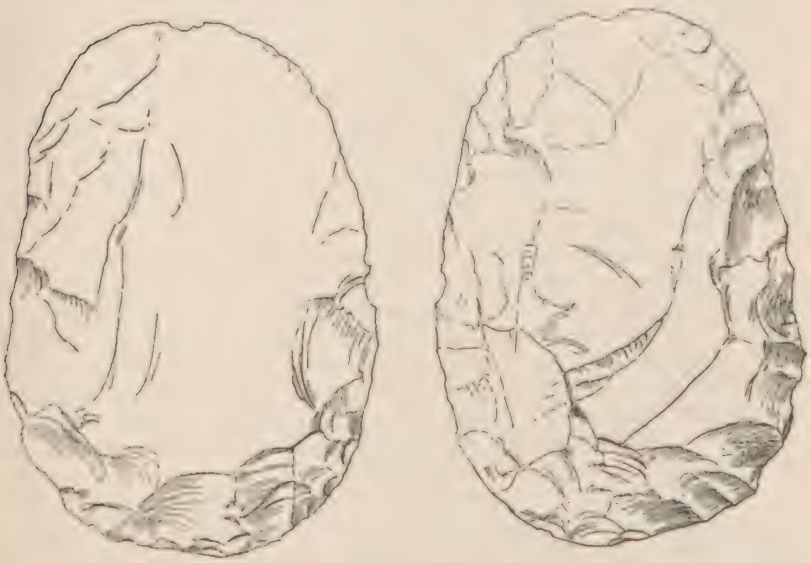

Fig. 77.—Ovate implement sharp all round, front and back views ($\frac{2}{3}$).

Northfleet floor illustrated in *Archæologia*, LXII., Pl. LXXIV., Fig. 1 (see p. 524). Naturally these would not often be left among the refuse, but the fortunate discovery of perfect specimens makes the identity of date and culture a moral certainty. It may be added in corroboration that among the Northfleet flints in the British Museum, and possibly contemporary with the bulk, are the following types also represented at the Graves, besides others already mentioned:—prismatic tool with handle, as Fig. 49; a cone, and another with spur, as Fig. 41; two broad flakes with spurs, as Figs. 52 and 53; six scrapers on blades, as Fig. 62; and a steep-edged tool with broad point and crust along the middle of the front.

Fig. 78.—Flake resembling a busked graver (⅔) B.M.

FIG. 78.—A thickish flake patinated creamy white all over, with a lustrous surface. This might be dismissed as an accidental form were it not that another almost identical was found in the top layer of Pit 1, of exactly the same length and patination. Both have a close resemblance to the busked graver (*burin busqué*) of the French caves dating from the Aurignac period, this variety being distinguished by longitudinal fluting at the point. This gives a somewhat rounded end to the facet from which the *coup-de-burin* has detached a slice: and it seems fairly certain that this forms a connecting link between the nosed scraper (that gradually became narrower) and the ordinary graving-tool, which is strangely rare in this country. Both specimens may be due to the accidents of flaking; but if many coincidences mentioned elsewhere are to have any weight, it may be pointed out that, at the date indicated, the graver was just at this stage of development in France.

During the excavations many specimens were collected from the surface away from the two shafts that were being re-opened, but their evidential value is inconsiderable in the absence of any *corpus* of local types, and very few can be noticed here. Dr. Sturge has a large series of surface finds from the Graves, kindly placed at our disposal for comparison and worthy of a memoir to themselves; but till the leading types from the pits are fully recognised, most collectors will be inclined to class them all under the vague and unsatisfactory heading of "Neolithic."

The Drift ovate is represented by a hand-axe with one flat face (I.M.), 3·5 in. long, and a squarish specimen with white patina a trifle longer (C.A.M.). A disc (B.M.) with crust on much of the flatter face, 5·4 in. across, is an unusually large example, with edge all round but much of the under-face a natural fracture. A large flat flake of lozenge form, 5·5 in. long (B.M.), tapering to a strong point which is trimmed only on one face, has a powdery white front (decayed patina) and a harder under-face also white, but otherwise resembles a dove-coloured specimen from floor 3B, 4·8 in. long. Another large flake (B.M.), 4.9 in. long, is white with a later black chip of uncertain (but not recent) date, and has edge-work in Le Moustier style* on what was formerly a hinge-fracture. The same period is recalled by a gabled "point" with *racloir* edges, 4 in. long; also by a kind of prismatic tool, 2·7 in. long, very thick with rounded point, closely resembling one in Dr. Sturge's collection from Le Moustier itself. A blade-implement with a notch in the edge is suggestive of the Abri Audi "point," length 3 in.; and a horse-shoe

* A similar specimen, 4½ in. long, from Cissbury, is in the Brighton Museum (Toms collection).

scraper, 4 in. wide, with steep engrailed edge is not unlike specimens from that rock-shelter (*cf.* floor 13, p. 199). A celt (B.M.), 4·8 in. long, rather in the Cissbury style but with irregular median ridge, has all three edges of the prism trimmed (variety of the "battered back"). A fine specimen of surface-flaking (C.A.M.) is like a Drift implement without its butt, and is 4 in. long. The sloping fracture below may be intentional; the edges are slightly zigzag and the patina a greyish white.

Another good specimen with a broad oval section is 3¾ in. long, with the edge zigzag on one side, and evidently of the same type as Fig. 23, neither being the "end of a celt." A blade of triangular section (B.M.), 4·7 in. long, from the field N.E. of the Graves, has one facet flaked transversely (form 2 of the *dos abattu*), the opposite edge bearing traces of use as a knife; and a cone (B.M.) of bluish grey, rather chalcedonic flint is 2·9 in. across the base, with a patch of crust on the apex and an engrailed edge with spurs and notches: it came from the field west of the Graves. A particularly large chopper (B.M.) in the form of a segmental tool, 4½ in. long and 3⅜ in. high, has one flat face, the base chipped flat and a fairly regular edge. A very close parallel, exactly the same length, is figured by Dr. Peake from Peppard (*Arch. Journ.*, LXX., 43, Fig. 6), and was presented, with all the other figured specimens from that site, to the British Museum.

In the above description repeated references to parallels from Cissbury would have been wearisome, but the correspondence between the two sites is by no means confined to the special instances mentioned. To determine their precise relation would necessitate another paper, but it may be said that while Grime's Graves seems to be based on Le Moustier, Cissbury is based on St. Acheul; and yet the English sites have so much in common that, on the evidence available, there can be no great difference in their dates.

The results of a close examination of the excavated flints may be presented in the form of alternative hypotheses, the reader being left to take his choice or to propose another that would satisfy all the conditions.

1. The first alternative is to regard the Graves as a Neolithic site, a view that has the obvious advantage of harmonising with the usual interpretation of the evidence from animal bones, shells and pottery; and is at the same time highly orthodox. If a majority vote is secured on these lines, it will be increasingly difficult to distinguish the products of the old and new Stone Ages in time to come; and if form has no chronological value, we shall have to admit that all the time and energy spent on classifying by horizons the industries of the French and Belgian caves, have been practically wasted. The dilemma is complete. If Neolithic man mined and chipped flint at Grime's Graves, he certainly eschewed his native patterns and modelled much of his output on Le Moustier forms of which he can have had no models and no memory; and to see that the very chipping apart from the form is identical, one has only to

turn to such illustrations of Le Moustier work as *Reliquiæ Aquitanicæ*, Plates XII. and XXVIII. If to this be added the close agreement of the types, it will be seen that the reporter must insist on these the closest parallels available, even though similar "survivals" have been noticed in the Campigny series,* generally assigned to the opening of the Neolithic period.

2. It may be held that the site was first occupied in Le Moustier—Aurignac times, but was disturbed by Neolithic man when he began to mine for raw material. In answer to this it may be observed that at least some of the "floors" are of the earlier date, and with such a supply of prepared flint lying on the surface, it is difficult to account for the mining energy of the newcomers. Further, whence did Palæolithic man get his material if not from mines? He seems to have left vastly more behind him than his Neolithic successor, and would have been all the more pressed for raw material.

3. Granted the resemblance or identity of certain specimens from Grime's Graves and Le Moustier sites, what French or Belgian cave (it might be asked) yields anything like the complete series of the Graves or Cissbury? It is useless to plead the isolation of Cave man in Britain, and an independent development of types from a common stock; for the caves of Britain yield much the same as the Continent throughout the Cave period. The difficulty becomes less serious when the question of raw material is considered. In the chalk areas of northern France (where the industry in question will probably be identified) and south-east England, flint could be got direct from the chalk in large nodules and unlimited quantity; whereas in the Dordogne and Belgium the nodules were of smaller size, and were used more economically. It would be a useful exercise to mould some of the Cave types magnified two or three diameters, when a more just comparison would be possible.

4. It has been thought in responsible quarters that this culture is simply a recrudescence in Neolithic times, the types of the early Cave-period having come into fashion again after an interval of unknown but certainly enormous length. Some play has been made with the re-appearance of Aurignac forms in the last third of La Madeleine period, as certified by the Abbé Breuil†; but a still greater effort of imagination is now demanded, to link Le Moustier and Neolithic man. Had the types of Le Moustier remained crystallised elsewhere, and been brought back to a region known to have been inhabited in Le Moustier times (*teste* High Lodge) by invaders who had never known any other culture? This is hardly credible in view of the fact that representative flints of the intervening periods have been found in caves and on the surface in several parts of England; and it is difficult to locate the backwater from which the hypothetical invaders came. It is also highly improbable that Le Moustier types would be produced in Neolithic

**Archæologia*, LXIII., 154.

† Geneva Congress (1912), *Compte-rendu*, Vol. 1, p. 231.

times without any admixture of types‡ then being produced elsewhere and at no great distance; and if it be urged that the Cissbury and other forms of the celt, pottery and domestic animals prove that admixture, then it becomes necessary to examine each of these "neolithic" traits in detail, and in each case weak spots in the argument can be indicated without much difficulty.§ By all the rules of typology the Grime's Graves series, if neolithic with palæolithic survivals, should contain more of La Madeleine than of Solutré, less of Aurignac and a minimum of Le Moustier. The exact converse is the case, and it is difficult to imagine an industry less like La Madeleine. Where are the shouldered blades of Solutré, the long sharp blades of La Madeleine or the pygmies of Tardenois? Positive evidence is also forthcoming in the shape of hand-axes in plenty. Though the *coup-de-poing* is hard to describe it is easily recognised by the archæologist; and even if Prof. Obermaier asserts its presence in the Solutré and Neolithic periods,‖ his colleague, the Abbé Breuil, has more than once denied that it survived the Aurignac period, and Prof. Commont says it almost entirely disappeared in late Moustier times.¶ Was the production suspended in the period of La Madeleine, and resumed without change of type in the totally different circumstances of the later Stone Age?

5. Another alternative is to regard the culture of Grime's Graves as homogeneous and contemporary, the evidence of the flints being strongly in favour of a date between Le Moustier and Aurignac. There are forms that link the Drift with Neolithic times, illustrating a process of evolution which one might have expected beforehand, but this is no reason for regarding the present series as "Mesolithic," a term that is doubly misleading since the Cave types were differentiated and the hiatus theory fell into discredit. Dr. Sturge has published in *Proceedings* (Vol. I., p. 210) a comprehensive paper on the discovery of Cave types in his neighbourhood, and it is significant that they are nearly all surface-finds, a remarkable exception being the series of 200 found below

‡ Thus the recrudescent Aurignac forms were found associated with the double-bedded harpoon (Geneva Congress, *Compte-rendu*, I., 231, Fig. 43).

§ See for example *Archæologia*, LXIII., 144–152. The mammoth fauna is sometimes conspicuously absent from deposits of the early Cave-period, as at Abri Audi itself. Dr. Lalanne's report (*Actes de la Société Linnéenne de Bordeaux*, LXII. (1907–8), 387) on the fauna is brief, as follows: "Dans la couche tout à fait inférieure, on rencontre quelques os brisés de bovidés et d'autres animaux encore, mais difficiles a déterminer. Le cheval est absent. Ce dernier se rencontre surtout dans les couches supérieures en compagnie d' un bovidé; les fossiles sont surtout des dents et des os longs qui ont été fendus pour en extraire la moelle et qu'on rencontre à l' état d' esquilles de petites dimensions." Later he states (p. 396): "Les renseignements fournis par la stratigraphie, par la faune, par l' industrie, tout révèle la fin de l' époque moustérienne." One hardly recognises the fauna of Le Moustier here, but Lartet and Christy at least mention the mammoth and the cave-lion from Les Eyzies, perhaps the upper part of the Abri Audi (*Reliq. Aquit.*, 182).

‖ *Die Steingeräte des französischen Altpaläolithikums* (1908), 49; *cf.* Rutot in Monaco Congress, i. 322.

¶ *Les Hommes contemporains du Renne*, 133.

sand on the edge of the plateau at Icklingham (*Proc.*, I., 292) which he himself compares with Grime's Graves specimens. The surface flake-implements are mostly small, and many of them have been worked at two or more periods; whereas the surface finds at the Graves (including the "floors" and upper levels of the pits) are pure and bluish white, and would be conspicuous objects. What more natural than for the later Palæolithic and Neolithic inhabitants to gather such material from the surface and re-flake according to their own requirements?

By way of a corollary to this fifth alternative may be added a few words with regard to the history of the site since the flints now excavated were left on the spot by their makers, for it is clear that they were not transported from elsewhere in their manufactured condition. Canon Greenwell's shaft is said to have been sunk through 13 ft. of sand before the solid chalk was reached; but the opportunity was recently taken of testing this important point, and it was found that a certain depth of the sandy filling-in had been mistaken for the wall of the shaft. Whether the site was ever covered with sand like the Icklingham plateau * is a debatable point, and a loose deposit might well have been swept off by the wind before the existing wood was planted. There was a persistent strong wind during the two months devoted to the work. In any case the present surface has not been disturbed to any great extent since these flints were chipped; and if they are of the period suggested above, the implication is that there has been no great cataclysm in the district since Le Moustier times,† that is (according to the majority) since the Würm glaciation. But this side of the Grime's Graves problem needs further consideration, and cannot be included in a description of the flints; though in connection with the alleged boulder-clay covering of Pit 1, attention may be drawn to the possibility of pleistocene deposits over flint mines of similar character at Meudon, between Paris and Versailles. M. Laville, a well-known Paris geologist, has discussed a drawing published by Cuvier and Brongniart of a section showing a filled-in shaft through cretaceous beds, with deer-antler picks at the bottom, and an apparently unbroken deposit over the shaft. This section is reproduced in *Bulletin et Mémoires de la Société d'Anthropologie de Paris*, 1912, 373.

M. Laville's opinion is best given in his own words:—Après examen de la Figure 1, on est forcé de reconnaître qui si elle est exacte, le puits et l'espèce de cavité ont été creusés avant la formation de la terre végétale; mais le dessin qui montre la séparation bien nette de la terre végétale au dessus du remplissage de la cavité est-il bien exact? En tous cas, je crois que ce puits, creusé avant ou après la formation de la couche d'humus, n'est pas un puits naturel, mais qu'il a été creusé par les hommes.

* *Journ. Anthrop. Inst.*, XLIV., 382.

† Superficial "floors" of Le Moustier date have been found abroad, as in the canton of Joyeuse, Ardèche, France (Prehistoric Congress of France at Nîmes, 71), and at Babadilla, Malaga, Spain (*L'Anthropologie*, XXIV. (1913), 14).

To forestall the criticism that this thick surface deposit is due to hill-wash or some other recent action, mention may be made of two deer-antler picks now in the Paris School of Mines, which are thus catalogued: Deux bois de cerf indiqués comme provenant de poches dans la craie remplies par le diluvium à Meudon. The diluvium, it may be added, corresponds to our Drift.

The reader will no doubt endeavour to base his opinion of the Grime's Graves culture on the evidence taken as a whole, and will find the task somewhat bewildering. He will read that the skull is not markedly palæolithic, and that the shells and fauna generally point to early Neolithic times; nor will he forget that marks of polished axes have been noticed in the galleries, and that pottery was evidently used by the flint-miners. Yet he may be reminded that all the familiar forms of flint discovered point in one direction, more precisely to a period represented in the French scheme by Abri Audi, between the first and second divisions of the palæolithic Cave-period.† He will realise that much of the evidence must be over-ruled or interpreted afresh, but it will not avail him to dismiss the parallels with dated Continental flints as mere accidents that might occur in any workshop refuse, whether ancient or modern. The arm of coincidence has not the length required.

† Abbé Breuil traces a gradual evolution from Le Moustier to Aurignac and denies the existence of a break between these cultures (*Compte-rendu*, Monaco Congress (1906), I., 320).

Pottery, Worked Bones, and Worked Chalk.

By REGINALD A. SMITH, F.S.A.

The remaining specimens that are evidently human handiwork will be considered together in the same order as before, beginning with the pits and galleries; and some general remarks added on one or two leading features of the Grime's Graves culture. It is fully recognised that any Stone Age find should be studied in the light of the associated fauna, and the reader is referred to pp. 68 and 90 for information on that point; but something may be said in favour of considering the flints and other artifacts apart, for two reasons: except in caves, the animal bones have a habit of disappearing almost completely, and what few are left may give a wrong impression of contemporary wild life; further, there is still some dispute as to the fauna of certain palæolithic horizons and the beginnings of domestication*, a fact that might prejudice the whole investigation.

PIT 1.

In layer 3, 10½ ft. below the charcoal band, was found a lump of chalk about 4½ in. long with a conical back and the front worn smooth, but not quite flat. This flat face is scored with a few straight and curved lines, but they appear to be unsystematic and are probably due to accident.

Fig. 79. Fragment of bowl and foot in section, duplicated to shew profile and diameter (½).

In the same layer, at a depth of 5 ft., some split bones, probably of the red-deer, lay between blocks of chalk; and in layer 8, at 27 ft, from the surface, in a similar matrix, 6 ft. from the eastern edge and 2 ft. from the mouth of gallery 1, were pottery fragments, mostly small but one large enough to shew the upper curve of a bowl with plain and thinner lip (as Fig. 79), of the typical

* See for example *Archæologia*, LXIII., 144—6.

Grime's Graves ware, which is hand-made, with plain, smooth buff or reddish surfaces and flint grit in the body; sometimes imperfectly fired, the black core varying in thickness. At the same level, 2 ft. from the western edge and just under one of the arches, were more pieces of the same ware, including five with the thinner lip and three portions of foot (perhaps of two vessels) a little spread, not forming a clean angle like Fig. 79, and giving a diameter of 1·7 in., about half that of the base illustrated. The range of thickness was from 0·3 in. to 0·35 in.

Three fragments, now joined and measuring together about $3\frac{1}{2}$ in. square, were found at a depth of 27 ft. below the top of the mound, between chalk blocks. The vessel must have had a diameter outside the lip of 5·6 in., and the walls are 0·3 in. thick, the plain rounded rim being somewhat thinner and curved inwards (Fig. 79).

In gallery 1 of this pit similar fragments, but larger than usual, were found buried between chalk blocks; the normal thickness is 0·3 in., and there are portions of rim as before described.

In the entrance of gallery 6, Pit 1, was found a lump of chalk 2·7 in. long with a maximum width of 1·5 in., having a rounded long side and shaped surface, as though it were an attempt to carve in the round.

In gallery 10, 3 ft. from the far end and 21 ft. from the entrance, was found a chalk lump with a conical hole 1 in. deep and $1\frac{1}{4}$ in. across at the mouth. This was not hollowed in the same way as the presumed lamps.

A gallery (No. 15) in Pit 1, 24 ft. long, led from the floor of Pit 1 to what seemed to be another shaft filled with tumbling débris, in which, among sand and flints that had once been on the surface, was found the tibia of a red deer, hacked and scratched, and hollowed by the removal of the cancellous tissue, the perforation being $\frac{3}{4}$–$1\frac{1}{2}$ in. in diameter. There were other split bones artificially hollowed in the same manner.

Pit 2 produced a good deal besides flints, and the following finds are roughly in descending order. As in Pit 1, pottery of the Grime's Graves type occurred between the chalk blocks of the filling, especially in layer 5. At 14–15 ft. below the cut edge (datum level) or 21–22 ft. below the top of the encircling mound (standard level) were found small and larger fragments uniformly 0·3 in. thick, of reddish-brown colour, imperfectly smoothed inside and out, but soft to the touch. Somewhat pinkish was the broken base of a vessel, 3·3 in. in diameter, with some tool marks outside: the bottom was uneven, but meant to be flat, forming a definite angle with the side (Fig. 79). About 2 ft. lower were found more fragments, including portions of the thinner incurved lip; one or two pieces were thicker than usual, reaching 0·4 in.

A block of chalk was cut out of the face of the shaft to preserve a vertical groove, apparently worn by a rope passing over a horizontal edge. The space worn away is $1\frac{1}{4}$ in. long, 1 in. across, and $\frac{1}{4}$ in. deep, and its position was above a cove of wall-flint on the N.E. side.

In gallery 4 of this pit was found a chalk ball about 2 in. in diameter, evidently shaped by man but not quite spherical*; and another lump about the shape of a cokernut, 5 in. by 4 in., and roughly shaped with a cutting tool. These may be classed with the chalk carvings† found in Canon Greenwell's pit, and now in the British Museum. At 2 ft. from the bottom of the shaft at the entrance to gallery 5, were found some scraps of typical Grime's Graves pottery, one being removed in the chalky matrix; and among the sherds collected, level with the head of this gallery (on N.W. side of the shaft), was a small fragment of lip, also a curved piece of the same ware, $2\frac{1}{2}$ in. by $1\frac{1}{2}$ in., and $\frac{1}{4}$ in. thick, smooth reddish surface, not quite baked through, and scratched on the outside. Several pieces measured less than 1 in.

Fig. 80. Pottery fragment with double cord-impression and top view of lip ($\frac{1}{1}$)

Two potsherds of the usual ware, one measuring 16 in., came from the west side of gallery 6, in rubble, 3 ft. from the shaft; and above the ledge of floor-flint, under the buttress between galleries 6 and 7, were other fragments, black on the inside surface, of dark reddish brown paste. Over the entrance to the latter were two pieces of the ordinary ware, but thicker than usual (0·4 in.), black with brown outer surface, found 19 ft. below the cut edge, in sand at the west side of the shaft.

Inside gallery 10, several pieces of similar ware were found 4 ft. from the entrance, close to the right wall and near the floor, and two now fitted together were remarkable for a groove along the middle line of the lip, and a double moulding just below produced by two horizontal cord impressions (Fig. 80). This is the only trace of ornament on any pottery claiming to be contemporary with the shafts; but among other fragments from this gallery was one piece measuring 2 in. by $1\frac{1}{2}$ in., which gives some idea of the complete vessel, with plain incurved rim (as in pit 1, gallery 1; and layer 5 in the second pit), about $5\frac{1}{2}$ in. in diameter.

*Mr. H. St. Gray has shewn me the chalk ball he found with the skeleton of a dwarf, 6 ft. deep, in the fosse at Avebury. It is 1·5 in. in diameter, and not so well shaped.

†*Journ. Ethnol. Soc.*, ii. (1870), 430.

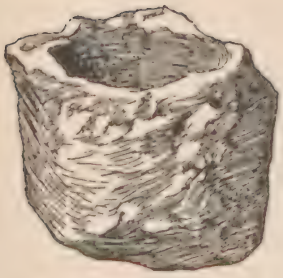

Fig. 81.—Hollowed chalk block, perhaps a lamp ($\frac{3}{4}$)

Apart from the flints, floor 4 yielded one of the most interesting specimens, in the shape of a chalk lamp (Fig. 81), such as might be supposed to have aided the miners in the excavation of the numerous galleries at the base of the shafts. This falls into line with four found by Canon Greenwell (B.M.) and serves as another link not only with Cissbury (*Archæologia*, LXIII., 118, Fig. 17) but with dated cave-deposits of the Continent. It is a lump of chalk 2 in. by $1\frac{1}{2}$ in., and $1\frac{1}{2}$ in. high, with an irregular conical cavity about $\frac{3}{4}$ in. deep, now rather dirty, with one recent chip showing white. The base is almost flat and the lamp would stand, but not quite upright. All these have been hollowed out purposely, and a large specimen of calcareous stone, 6 in. in diameter, with a natural cavity probably used for the same purpose, was found in the mid-Aurignac level at La Ferrassie, Dordogne,* and left unexplained by MM. Capitan and Peyrony. Other authorities venture to call them lamps; and Déchelette (whose distinguished career as an archæologist has been crowned by a soldier's death at the front) supports this view, giving as usual all the necessary references (*Manuel*, I., 173), except perhaps Dr. Baudon's list in *Bull. Soc. d'études hist. et scient. de l'Oise*, VII. (1911). Their purpose was finally made clear by the discovery of one of stone in the Grotte de la Mouthe, Dordogne, where the artists who decorated that long gallery would constantly have required artificial light.

In the excavation called the Beaver Pit, at a depth of $2\frac{1}{2}$ ft., were found a bone with scratches probably due to the claws of some animal, and a perforated chalk disc just like a spindle-whorl, 1·5 in. across, with a maximum thickness of 0·6 in., and a round hole fairly central, but worn on one face to an oval at the mouth. It came from the centre of the pit, and should be compared with one of exactly the same diameter from an Early Iron Age interment at Danes Graves, E.R., Yorks,† rather than with the larger rings found both at Grime's Graves and Cissbury, that cannot have served as whorls, and were probably worn as beads. Canon Greenwell found an irregular oval with small hour-glass perforation in his pit at 18 ft., 2·5 in. by 2·2 in., and 1·1 in. thick; and two better specimens, also in the British Museum, were found at Cissbury—one 3 in. in diameter and 0·8 in. thick, with deep markings more or less radiating on both faces, and lines from face to face in the perforation, which is 0·8 in. across; the other measuring 3 in. by $2\frac{1}{2}$ in., and 0·7 in. thick with oval hour-glass perforation 0·4 in. long from the rampart, 6 ft. from the top in the

* *Revue Anthropologique*, Jan., 1912, 94, Fig. 32.

† Figured by Canon Greenwell in *Archæologia*, LX., 271., Fig. 20.

centre. Another found at Cissbury was 2–2½ in. across, ¾ in. thick, with a hole ½ in. across.*

A good deal of material quite different from that of the recognised pits or floors came from a cutting known as section 7 (p. 115), between the tumulus and the north-eastern group of the Graves. From a cup-shaped black layer much pottery was recovered, belonging to large vessels, thick, hard, and heavy, with a pale yellow surface on the outside. The best fragment for dating purposes is 3·3 in. long, and has a plain square lip, with two circular perforations† just below it in a horizontal line, and below them a small round boss (Fig. 82). There are sloping incised lines on the upper edge, and some mica present in the clay, which is black. The thickness of various specimens of this ware ranges from 0·25 in. to 0·8 in.; and fragments of bases suggest diameters of 3 in., 3·7 in., 3·8 in., 4·8 in., and 7·4 in. Lip fragments were generally insufficient to give the mouth diameter, but one was about 6·6 in. across, with a thickness of 0·6 in.

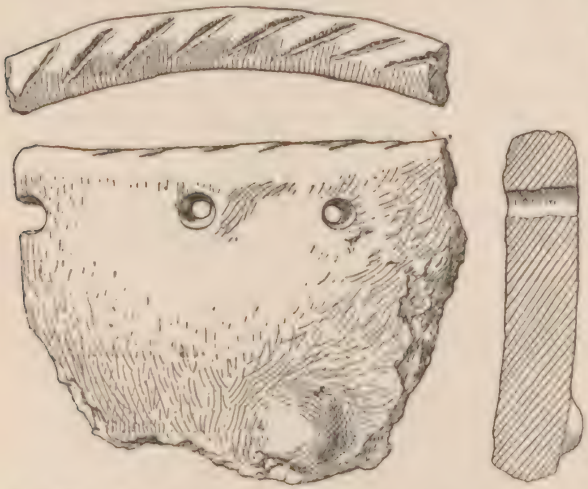

Fig. 82.—Pottery fragment with holes below lip, with top view and section (⅔)

One fragment has two parallel incised lines made before firing on the outside face, and another transverse grooves at intervals of 0·2 in. on the flat rim, the calculated diameter being in this case 3·7 in., and the black body showing beside the yellow on the rim itself. Another with pinkish yellow surface and mica dust has the lip ornamented with regular sloping lines; and in another case the lines are curved, almost comma-like on the rim, which is 0·45 in. thick. Two other fragments have a raised band with finger-nail indentations (Fig. 83), and inside several was a layer of soot. The included grit is well seen on a fragment, ½ in. thick, which is grey with reddish buff outside; other

* *Journ. Anthrop. Inst.*, V., pl. xviii., Fig. 6, see p. 379.

†It has been suggested that these were made with one of the pointed bone tools that exactly fits.

pieces with yellowish surface and less grit were 0·3 in. thick, the average from this site being 0·5 in. All this pottery was baked fairly hard, and can have nothing to do with the ware found deep in the shafts; but it is not easy to suggest a date, as the known

Fig. 83.—Pottery fragment with finger-nail pattern on raised band, with section ($\frac{2}{3}$)

Neolithic, Bronze Age, and later wares of Britain have quite different characteristics.

Many marked bones were found in this section at a depth of 3 ft., associated with the pottery just described, pot-boilers of flint, pebbles from the sand and Boulder clay, and bones of domestic animals. A broken skewer of sheep's bone, polished and artificially

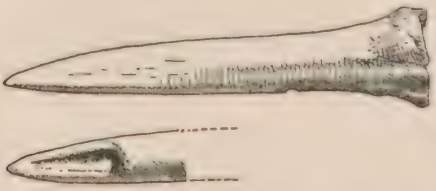

Fig. 84.—Bone skewer, with back view of point ($\frac{2}{3}$)

hollowed (Fig. 84), is made in the same way as several (B.M.) found in the grave of an Early Iron Age warrior at Grimthorpe, E.R. Yorks. (*Archæologia*, LX., 257, fig. 7). A polished bone

Fig. 85.—Bone skewer, perhaps used in potting ($\frac{2}{3}$)

skewer (Fig. 85) not only fits the holes in the pottery vessel already mentioned, but may have served as a potter's tool. There was another polished skewer broken at the point and hollowed as usual, and a splinter of fresh-looking bone, polished and cut across

Fig. 86.—Bone with transverse cuts ($\frac{2}{3}$)

superficially in five places (Fig. 86). Another bone splinter, shaped and pointed, may be described as a pin. Several other bones had been hacked or marked transversely, possibly in removing the flesh, but one deserves special notice on account of its many transverse black markings, which are, however, probably accidental.

The section cut in the tumulus produced a few small fragments of pottery from the burnt interment; the largest measuring 1·3 in. by 0·8 in., with a black coating inside due to fire, as ash was still clinging to it. Its colour is brown or honey colour, and though thicker than the rest, it has like them quartz sand included in the paste. The smaller pieces vary in thickness from 0·2 in. to 0·4 in., with a grey black body and reddish outer surface, merging into yellowish brown or black. One piece is curved as though from the side of a flat base, but no diameter can be determined. In the south section of the tumulus two small fragments of pottery were found 1 ft. and 4 ft. deep in a sandy layer, respectively thicker and thinner than the normal Grime's Graves ware, the thicker having a black core.

The ware that is obviously connected with the shafts and galleries is surprisingly good, and can be easily recognised, though grit (used no doubt to give resistance in firing) is not always present in the paste.

To the many parallels from Cissbury noticed above, may be added one by no means the least important. Pottery found there is thus described by Col. A. Lane-Fox (Pitt-Rivers) in *Journ. Anthrop. Inst.*, V. (1876), 381. "At a depth of 13 ft. below the surface in the filling, three pieces of a different description (from those found in the superficial soil and the ditch of the earthwork) were found by me in my previous diggings. This pottery was of two kinds, one red on the outside, $\frac{1}{2}$ in. thick, mixed with large

fragments of white quartz, some of which were as much as $\frac{1}{5}$ in. in size (Pl. xviii., Fig. 7); the other a fragment of the rim of a large vessel (Pl. xviii., Fig. 8) of dark brown pottery, hand-made, about $\frac{1}{5}$ in. thick, mixed with smaller grains of quartz. This last, as shewn by the fragment of the rim, must have been a vessel about 9 in. in diameter at the mouth, and enlarged to 13 in. at about 2 in. from it. The texture of this pottery found in the shaft shews it to be of coarser quality than any found on the surface or in the ditch in Cissbury. Another fragment of this coarser kind was now found 18 ft. from the surface, and consequently some distance below the line of the red seam." Most of these fragments have not been identified, though there are several labelled boxes of Cissbury specimens in the British Museum; but the fragment found 18 ft. from the surface closely corresponds to the normal Grime's Graves ware in all but thickness, measuring as it does 0·5 in. against 0·3 in. Though described as coarse by its discoverer, it is good compact clay of reddish brown colour, with a large proportion of flint grit. It has a slight curve, and both faces are smoothed with some care. Except that the grit is coarser than that of the Grime's Graves ware, the two specimens are surprisingly alike in texture, and may provisionally be ascribed to the same civilisation.

The description of the flints will, at least, have raised a suspicion that the flint-mines belong to the early part of the palæolithic Cave-period; and those who favour a neolithic date will rely not least of all on the presence of pottery, long regarded as an art unknown to palæolithic man. Till the problem has been discussed in the light of our excavations, dogmatism would be out of place, but there is some evidence in favour of pottery in Aurignac times. With the few flints and animal bones presented to the British Museum by the Rev. S. W. King, F.S.A., who explored Aurignac (40 miles S.W. of Toulouse) in 1865, are several pottery fragments, all but one (a base) bearing the original labels, as though considered contemporary with the rest. There are one or two pieces of black ware with brick-red facing, 0·3 in. thick, the paste being more sandy and a good deal harder than the Grime's Graves ware; a small dark-grey piece with yellow surface inside and out is 0·8 in. thick and difficult to date; and the unlabelled base, 3 in. across, might well be disregarded if it were not just the same shape and almost the same size as the base found in our Pit 2, showing in one part a slight spreading of the foot exactly like the fragments mentioned from layer 8 of Pit 1. The ware is of the same thickness and general appearance, though the composition must vary with the local clay, and an exact resemblance would not be expected on two sites so far apart. This coincidence leads one to inquire whether experts were justified in rejecting the pottery from the burial cave at Aurignac as later than the pleistocene deposits that formed the floor of that recess. The discovery was made through a fissure by a labourer, and several skeletons were removed and buried in the churchyard. It is surmised by some who never saw the bones that the burials were later insertions, and Sir Charles Lyell was converted to that

view.* The point can hardly be settled now by evidence from that particular site, and the absence of pottery from any Cave-deposits of the same period in southern France is certainly a strong argument in favour of a later date for these sherds; but it is well to bear Mr. King's discovery in mind pending further exploration elsewhere.

The occurrence of pottery in late palæolithic deposits has long been a subject of discussion, and both sides are convinced that facts are in their favour. From the admirable summing-up in Déchelette's *Manuel*, it is clear that the two sides are represented respectively by the French and Belgian archæologists, the former denying the existence of pottery at that date in French cave-deposits (at least south of the Loire), and inferring its absence elsewhere; the latter school affirming its repeated discovery in Belgian caves, and suspecting that it has been found elsewhere, but attributed by the excavators to neolithic or later intrusions. In this country there would certainly be a large majority against palæolithic pottery, but negative evidence is of little weight in such matters, and the undoubted discovery of a few sherds in an undisturbed palæolithic deposit would suffice to turn the scale. This is not the place to review the whole question,† but rather to state the facts that emerge from the systematic exploration of the two pits at Grime's Graves, the date of which should soon be a matter of certainty.

Scepticism on this point must be expected, and is indeed the scientific attitude; but the results of careful excavations can be cited on both sides. The prevailing opinion is no doubt based on the French evidence, accumulated by Lartet and Christy as well as by later distinguished archæologists; but it is generally allowed that Ed. Dupont's work in the Belgian caves proves his accuracy and acumen; and his testimony on such a vital point is confirmed by Dr. Alfred Rutot in two papers‡ and in a letter to the President, from which a quotation is kindly allowed: "Twelve caverns in Belgium have yielded fragments of pottery—1. Upper Le Moustier horizon, Hastière. 2. Mid Aurignac horizon, third Goyet cavern. 3. Upper Aurignac horizon, Trou Magrite (Pont-à-Lesse), and third Goyet cavern. 4. Lower La Madeleine horizon, third and second Goyet caverns. 5. Mid La Madeleine horizon, Trou des Nutons and Trou du Frontal." Absolute proof is wanting and cannot now be obtained from these caverns, hence some of the sherds may be of neolithic date; but Dr. Rutot has himself found in the cave known as Fond-de-Forêt two fragments of pottery in the upper Aurignac level. The main and most conclusive discovery was, however, at Le Caillou-qui-Bique, where about 500 fragments§

* Boyd Dawkins, *Cave-hunting*, 245; *Nature*, 13th July, 1871, p. 208. The presence of bones of the sheep or goat influenced the decision, perhaps improperly.

† Some cases are cited in *Archæologia*, LXIII., 150.

‡ *Bull. Soc. préhist. de France*, 1907-8.

§ The best series is in the Cinquantenaire Museum at Brussels; but there are several fragments in the British Museum from the third Goyet cave near Namur (second level, upper Aurignac).

were associated with an upper Le Moustier industry, that date being preferable to lower Aurignac in view of Capt. Bourlon's discoveries at Le Moustier itself. The principal Belgian site is in the open air, a fact that is, in Dr. Rutot's opinion, enough to explain the absence of fauna. This large find of palæolithic pottery does not contain quartz or other grit mixed with the paste; but some of M. Dupont's specimens contain grit, often of calcareous stone.

The above valuable remarks were drawn from Dr. Rutot by the announcement that the President had found pottery in association with an alleged Aurignac industry on a "floor" now covered with sand at Messrs. Bolton and Laughlin's pit, north of Ipswich. This sensational discovery has been published,* and the pottery has been carefully examined side by side with what may be called the Grime's Graves ware. There is a marked difference of paste and form, the most striking Ipswich fragment being a rounded shoulder with sharply out-turned lip, of very coarse ware, belonging to a vessel about 14¼ in. across the mouth. Other fragments are slightly ornamented and ribbed, and the nearest approach to the Grime's Graves ware is in a few thinner black pieces with red exterior, baked hard with a good deal of sand, and recalling the red fragments from Aurignac.

In conclusion, one argument that might easily be overlooked may be commended especially to those who deny the existence of palæolithic pottery, and place the Campigny culture at the very beginning of the neolithic period. The pottery from that famous site, 25 miles east of Dieppe, is of advanced type,† and certainly not man's first essay in the art. Unless the invention was made and considerable skill attained in the mythical hiatus, when *ex hypothesi* man was not living in this part of the world, the conclusion is irresistible that pottery was a far earlier achievement of the human race, and therefore palæolithic. Such reasoning seems to be borne out to the letter by the Belgian finds, which open the door for unexpected developments in England.

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* *Ipswich Field Club Journal*, 1913; *Journ. R. Anthrop. Inst.*, XLIV., 376.

† *Rev. de l'École d'Anth. de Paris*, 1908, 403; some illustrations reproduced by Dr. Munro, *Palæolithic Man*, pl. xxxi.

Mammalian and other Bones.

By C. W. Andrews, D.Sc., F.R.S.

MAMMALIA.

TALPIDÆ.

Talpa europæa, Linn. (The Common Mole).

CHIROPTERA.

(Identified by Mr. Knud Andersen).

Myotis daubentoni, Kuhl. (Daubenton's Bat).
Myotis nattereri, Kuhl. (Natterer's Bat).
Myotis bechsteini, Kuhl. (Bechstein's Bat).
(The only known British specimens were captured a hundred years ago in the New Forest, and in 1902 at Henley-on-Thames and in Sussex. It is a forest-haunting species).
Myotis mystacinus, Leisl. (Whiskered Bat).

CANIDÆ.

Canis, sp. (Dog).
Vulpes vulpes, Linn. sp. (Fox).

LEPORIDÆ.

Oryctolagus cuniculus, Linn. sp. (Rabbit).

CASTORIDÆ.

Castor fiber, Linn. (Beaver).

MURIDÆ.

(Partly determined by Mr. Martin Hinton).

Apodemus sylvaticus, Linn. sp. (Long-tailed Field Mouse).
Microtus agrestis, Linn. sp. (Field Vole).
Evotomys glareolus, Schreb. sp. (Bank Vole).

EQUIDÆ.

Equus caballus, Linn. (Horse).

SUIDÆ.

Sus, sp. (Pig).

CERVIDÆ.

Cervus elaphus, Linn. (Red Deer).
Capreolus capreolus, Linn. sp. (Roe Deer).

BOVIDÆ.

OVIS. (Sheep).
BOS (? LONGIFRONS). (Ox).

AVES.

TURDIDÆ.

? TURDUS. (Thrush).

STURNIDÆ.

? STURNUS VULGARIS, Linn. (Starling).

REPTILIA.

TROPIDONOTUS NATRIX, Linn. sp. (Grass Snake).

AMPHIBIA.

BUFO VULGARIS, Laur. (Common Toad).

[For list of bones found in the layers and galleries of Pit 1 see p. 68, and for those found in Pit 2 see page 90.]

FLOOR.

3. Red Deer, antler; Pig, teeth.

TUMULUS.

Sheep, 2½ ft.; Horse, tooth, 2 ft.; Red Deer, tine cut off; Deer; Ox, 10 ft.

SECTIONS.

3. Red Deer, bones, and antler used as hammer; Ox.
4. Ox.
7. Red Deer, toe and patella; Ox (probably *Bos longifrons*), part of skull, 2½ ft.; large quantity of Horse, Sheep, Ox.
10. Red Deer.
11. Beaver Pit. Beaver, skull; Deer, tooth; tip of horn of sheep 2 in. long, cut off; Sheep and Ox (considerable quantity).
12. Dog; Deer; small Sheep; Ox.
13. Red Deer antler used as hammer.
14—15. Ox, tooth; Red Deer, astragalus, 2½ ft. (Prof. Kendall).

The bones are preserved at Cambridge Museum of Archæology, Ipswich Museum, and Norwich Museum.

The Mollusca.

By A. S. Kennard, F.G.S., and B. B. Woodward, F.L.S., F.G.S., etc.

As a rule, the shells of the non-marine Mollusca receive but scant attention by archæological explorers; it is therefore a matter of congratulation that during the excavations at Grime's Graves these remains were carefully collected. A very large series with the data of the layers in which they were found was duly forwarded to us for examination and report. It was a fortunate circumstance for our special branch that our friend, Mr. A. Mayfield, was present for several days, since his extensive knowledge of our recent Mollusca enabled him to make a series of most valuable notes which he kindly placed at our disposal, and for which we now place on record our grateful thanks.

With the exception of layer 1 the infilling of the pits is mainly artificial, whilst the sections shew that this operation was intermittent, and that the pits were used as tips for the waste material obtained from adjoining pits which were being excavated. Many of the shells and probably all the smaller species lived where they were found, but a number of the larger forms, as suggested by Mr. Mayfield, have rolled down the slopes from above, and hence all the shells in a given layer are not contemporary. The truth of this statement can be easily seen by an examination of the shells themselves. Thus the contemporary shells from "layer 3, Pit 1" are either full of chalk débris or else practically empty and exhibit practically no weathering. With them were a number of examples of *Helix nemoralis*, coated with chalky matter derived from percolating water, which were filled with humus. They were decidedly weathered, and there can be no doubt that their original place of deposit was the top soil.

As a rule only the larger forms had been collected, but from the earth contained in these shells we were able to obtain many of the smaller species, but none were found in the derivative shells. Careful washing of various samples of soil also yielded many small forms.

The constant presence of these small species within the larger ones may arise from two causes. A large shell would no doubt be a suitable hybernaculum, whilst the remains of the dead mollusk within the shell would tempt the smaller species, for many mollusks, though normally vegetarian, are by no means averse to animal food if it can be obtained. We have tabulated the various species from each layer as received by us. With regard to frequency, when more than fifty examples of a species were present we have considered it as "abundant," when under fifty and over ten as "common." Owing to the good state of preservation in which the shells were, we have been able to give the band formulæ of nearly the whole of the adult examples of *Helix nemoralis*, Linn., and *H. hortensis*, Müll.

PIT 1.

TOP SOIL.

HELIX NEMORALIS, Linn. 11 examples. The band formulæ represented are :—

1 2 3 4 5 — 6 examples.
(1 2 3 4 5)— 2 ,,
1 2 3 (4 5)— 1 example.
1 0 3 4 5 — 1 ,,
0 0 0 0 0 — 1 ,,

BASE OF LAYER 1.

VITRINA PELLUCIDA (Müll.) 1 example.
POLITA SYDNEYENSIS (Cox). 8 examples.
VITREA CRYSTALLINA (Müll.) 7 examples.
ARION, Sp. 5 granules.
PYRAMIDULA ROTUNDATA (Müll.) 5 examples.
HELICELLA ITALA (Linn.) 2 examples.
HYGROMIA HISPIDA (Linn.) 3 examples.
VALLONIA EXCENTRICA, Sterki. 5 examples.
HELICIGONA LAPICIDA (Linn). 4 examples.
HELIX NEMORALIS, Linn. Common.
,, HORTENSIS, Müll. Abundant.
COCHLICOPA LUBRICA (Müll). 1 example.
PUPILLA MUSCORUM (Linn.) 3 examples.
CLAUSILIA LAMINATA (Mont.) 2 examples.
POMATIAS ELEGANS (Müll.) Common.

The band formulæ of HELIX NEMORALIS are :—

1 2 3 4 5 — 15 examples.
(1 2) 3 (4 5)— 3 ,,
(1 2 3 4 5)— 2 ,,
1 2 3 (4 5)— 1 ,,
1 0 3 4 5 — 2 ,,
0 0 3 4 5 — 3 ,,
0 0 3 0 0 — 6 ,,
0 0 0 0 0 — 9 ,,

The band formulæ of HELIX HORTENSIS are :—

(1 2 3 4 5)— 43 examples.
1 (2 3)(4 5)— 3 ,,
1 (2 3 4 5)— 2 ,,
1 2 3 4 5 — 2 ,,
0 0 0 0 0 — 32 ,,
1 0 3 4 5 — 1 example.

FROM BETWEEN CHALK BLOCKS.—LAYER 2.

VITREA CRYSTALLINA (Müll.) 4 examples.
POLITA SYDNEYENSIS (Cox). 1 example.
PYRAMIDULA ROTUNDATA (Müll.) 2 examples.
HELICELLA ITALA (Linn.) 1 example.
HYGROMIA HISPIDA (Linn). 1 example.
ACANTHINULA ACULEATA (Müll.) 1 example.
VALLONIA EXCENTRICA, Sterki. 2 examples.
HELICIGONA LAPICIDA (Linn.) 1 example.
HELIX NEMORALIS, Linn. Common.
„ HORTENSIS, Müll. Abundant.
CÆCILIOIDES ACICULA (Müll.) 1 example.
CLAUSILIA BIDENTATA (Ström). 1 example.
CARYCHIUM MINIMUM, Müll. 2 examples.
POMATIAS ELEGANS (Müll.) Common.

The band formulæ of HELIX NEMORALIS are:—

1 2 3 4 5	— 10	examples.
(1 2) 3 (4 5)	— 3	„
(1 2 3 4 5)	— 2	„
1 2 3 (4 5)	— 6	„
(1 2 3) (4 5)	— 2	„
1 0 3 4 5	— 3	„
0 0 3 4 5	— 4	„
0 0 3 0 0	— 4	„
0 2 3 (4 5)	— 1	example.

There were also 7 examples in which the band formulæ for practically all the shell was 1 2 3 4 5, but at the mouth there was a sudden coalescence of the bands.

The band formulæ of HELIX HORTENSIS are:—

(1 2 3 4 5)	— 36	examples.
1 (2 3) (4 5)	— 2	„
0 0 0 0 0	— 22	„

LAYER 3.

LIMAX ARBORUM, Bouch-Chant. 1 example.
VITRINA PELLUCIDA (Müll.) Common.
VITREA CRYSTALLINA (Müll.) Abundant.
POLITA SYDNEYENSIS (Cox). 6 examples.
„ NITIDULA (Drap.) 2 examples.
„ RADIATULA (Alder). 6 examples.
„ PURA (Alder). Common.
EUCONULUS FULVUS (Müll.) 1 example.
ARION, sp. Abundant.
PYRAMIDULA ROTUNDATA (Müll.) Abundant.
HELICELLA ITALA (Linn.) 9 examples.

HYGROMIA HISPIDA (Linn.) Common.
ACANTHINULA ACULEATA (Müll). Common.
VALLONIA COSTATA (Müll.) Common.
„ EXCENTRICA, Sterki. Common.
HELICIGONA LAPICIDA (Linn.) 4 examples.
ARIANTA ARBUSTORUM (Linn.) 1 example.
HELIX NEMORALIS, Linn. Abundant.
„ HORTENSIS, Müll. Abundant.
ENA OBSCURA (Müll). 6 examples.
COCHLICOPA LUBRICA (Müll.) Abundant.
PUPILLA MUSCORUM (Linn.) Common.
VERTIGO PYGMÆA (Drap.) 2 examples.
TRUNCATELLINA MINUTISSIMA (Hart.) 3 examples.
CLAUSILIA LAMINATA (Mont.) 1 example.
„ BIDENTATA (Ström). Common.
CARYCHIUM MINIMUM, Müll. Abundant.
ACICULA LINEATA (Drap.) Common.
POMATIAS ELEGANS (Müll.) Abundant.

The band formulæ of HELIX NEMORALIS are:—

1 2 3 4 5 —	140	examples.
(1 2) 3 (4 5)—	16	„
(1 2 3 4 5)—	29	„
(1 2 3)(4 5)—	10	„
1 (2 3)(4 5)—	2	„
1 2 3 (4 5)—	37	„
1 0 3 4 5 —	21	„
0 0 3 4 5 —	26	„
0 0 3 0 0 —	32	„
0 0 0 0 0 —	89	„

There were also 63 examples with the bands coalesced at the mouth as previously noted.

The band formulæ of HELIX HORTENSIS are:—

1 (2 3)(4 5)—	9	examples.
(1 2 3 4 5)—	109	„
(1 2 3)(4 5)—	6	„
1 2 3 4 5 —	6	„
0 0 0 0 0 —	56	„
1 2 3 (4 5)—	1	example.
1 (2 3 4 5)—	1	„

BLACK BAND.—LAYER 4.

VITRINA PELLUCIDA (Drap.) 1 example.
VITREA CRYSTALLINA (Müll.) Abundant.
POLITA SYDNEYENSIS (Cox). Abundant.
„ NITIDULA, (Drap.) Common.
„ PURA (Alder). Common.
„ RADIATULA (Alder). Common.

EUCONULUS FULVUS (Müll.) 4 examples.
ARION, Sp. 6 granules.
PUNCTUM PYGMÆUM (Drap.) 1 example.
PYRAMIDULA ROTUNDATA (Müll.) Abundant.
HYGROMIA HISPIDA (Linn). Common.
ACANTHINULA ACULEATA (Müll.) Common.
VALLONIA EXCENTRICA, Sterki. 2 examples.
„ COSTATA (Müll.) 6 examples.
HELICIGONA LAPICIDA (Linn.) Common.
HELIX NEMORALIS, Linn. Common.
„ HORTENSIS, Müll. Common.
ENA OBSCURA (Müll.) 4 examples.
COCHLICOPA LUBRICA (Müll.) Common.
PUPILLA MUSCORUM (Linn.) 2 examples.
VERTIGO PYGMÆA (Drap.) 1 example.
„ PUSILLA (Müll.) 1 example.
BALEA PERVERSA (Linn.) 1 example.
CLAUSILIA LAMINATA (Mont.) Common.
„ BIDENTATA (Ström). Abundant.
CARYCHIUM MINIMUM, Müll. Abundant.
POMATIAS ELEGANS (Müll.) Abundant.
ACICULA LINEATA (Drap.) Common.

Six ova, probably of Helicoids, were also detected.

The band formulæ of HELIX NEMORALIS are:—

1 2 3 (4 5)— 2 examples.
(1 2 3 4 5)— 2 „
0 0 0 0 0 — 2 „
(1 2 3)(4 5)— 1 example.
0 0 3 4 5 — 1 „
0 0 3 4 0 — 1 „
0 0 3 0 0 — 1 „

The band formulæ of HELIX HORTENSIS are:—

(1 2 3 4 5)— 16 examples.
0 0 0 0 0 — 2 „

LAYER 5.

PYRAMIDULA ROTUNDATA (Müll.) 1 example.
HELICIGONA LAPICIDA (Linn.) 5 examples.
HELIX NEMORALIS, Linn. 2 examples.
„ HORTENSIS, Müll. 10 examples.
POMATIAS ELEGANS (Müll.) 1 example.

The band formulæ of HELIX NEMORALIS are:—

(1 2 3 4 5) — 2 examples.

The band formulæ of HELIX HORTENSIS are:—

(1 2 3 4 5) —10 examples.

LAYER 6.

POLITA SYDNEYENSIS (Cox). 1 example.
HELIX NEMORALIS, Linn. 1 example.
„ HORTENSIS, Müll. 3 examples.

The band formulæ of HELIX NEMORALIS are:—0 0 0 0 0, and of HELIX HORTENSIS, 0 0 0 0 0 and (1 2 3 4 5)—2 examples.

LAYER 7.—14 ft. below datum.

HELIX NEMORALIS, Linn. 1 example, 0 0 3 0 0.
„ HORTENSIS, Müll. 3 examples all (1 2 3 4 5).

LAYER 8.—20 ft. below datum.

PYRAMIDULA ROTUNDATA (Müll.) 1 example.
HELICIGONA LAPICIDA (Linn.) 1 example.
HELIX NEMORALIS, Linn. 1 example.
„ HORTENSIS, Müll. 4 examples.

The band formulæ of HELIX NEMORALIS are:—0 0 3 0 0, and of HELIX HORTENSIS (1 2 3 4 5)—3 examples; 0 0 0 0 0—1 example.

IN SANDY LAYER OVER MOUTH OF GALLERY 7.

HELIX HORTENSIS, Müll. 1 example. Band formula:—
(1 2 3 4 5)

COVE OF WALLSTONE ABOVE ENTRANCE TO GALLERY 2.

HELIX HORTENSIS, Müll. 1 example. Band formula:—
1 2 3 4 5

FROM 29 FEET IN RUBBLE OF LAYER 10, OPPOSITE ENTRANCE TO GALLERY 8.

HELIX NEMORALIS, Linn. 1 example. Band formula:—
0 0 3 0 0

IN GALLERY 1.

POLITA SYDNEYENSIS (Cox). 6 examples.
PYRAMIDULA ROTUNDATA (Müll.) 2 examples.

FLOOR OF GALLERY 2.

POLITA SYDNEYENSIS (Cox). 2 examples.

PIT 2.

LAYER 2.—CHALK RUBBLE.

VITRINA PELLUCIDA (Müll.) 9 examples.
VITREA CRYSTALLINA (Müll.) Common.
POLITA SYDNEYENSIS (Cox). Common.
„ NITIDULA (Drap.) 1 example.
„ RADIATULA (Alder). 2 examples.
„ PURA (Alder). Common.
ARION, Sp. 9 granules.
PYRAMIDULA ROTUNDATA (Müll.) Common.
HELICELLA ITALA (Linn.) 1 example.
HYGROMIA HISPIDA (Linn.) 10 examples.
„ LIBERTA (West.) 1 example.
ACANTHINULA ACULEATA (Müll.) 7 examples.
VALLONIA EXCENTRICA, Sterki. 1 example.
„ COSTATA (Müll.) Common.
HELICIGONA LAPICIDA (Linn.) 5 examples.
HELIX NEMORALIS, Linn. Abundant.
„ HORTENSIS, Müll. Common.
COCHLICOPA LUBRICA (Müll.) Common.
PUPILLA MUSCORUM (Linn.) 3 examples.
CLAUSILIA LAMINATA (Mont.) Common.
„ BIDENTATA (Ström). 3 examples.
CARYCHIUM MINIMUM, Müll. Common.
POMATIAS ELEGANS (Müll.) Abundant.
ACICULA LINEATA (Drap.) Common.

The band formulæ of HELIX NEMORALIS are:—

1 2 3 4 5 —| 46	examples.
(1 2 3 4 5)— 29	„
(1 2) 3 (4 5)— 5	„
1 2 3 (4 5)— 8	„
(1 2 3)(4 5)— 3	„
0 0 0 0 0 —| 13	„
1 0 3 4 5 — 7	„
0 0 3 0 0 — 1	example.
(1 2) 3 4 5 — 1	„

There were also 12 examples with the bands coalesced at the mouth as previously noted.

The band formulæ of HELIX HORTENSIS are:—

(1 2 3 4 5)—23	examples.
1 (2 3)(4 5)— 2	„
1 (2 3 4 5)— 3	„
1 2 3 4 5 — 2	„
0 0 0 0 0 —14	„

BLACK BAND.—LAYER 3.

VITRINA PELLUCIDA (Müll.) 2 examples.
VITREA CRYSTALLINA (Müll.) Common.
POLITA SYDNEYENSIS (Cox.) 3 examples.
„ PURA (Alder). 4 examples.
„ RADIATULA (Alder). 2 examples.
PYRAMIDULA ROTUNDATA (Müll.) Common.
ARION, sp. 6 granules.
HYGROMIA HISPIDA (Linn.) Common.
HELICELLA ITALIA (Linn.) 2 examples.
ACANTHINULA ACULEATA (Müll.) 1 example.
VALLONIA COSTATA (Müll.) Common.
HELICIGONA LAPICIDA (Linn.) 1 example,
HELIX NEMORALIS, Linn. Common.
„ HORTENSIS, Müll. Common.
ENA OBSCURA (Müll.) 2 examples.
COCHLICOPA LUBRICA (Müll.) 8 examples.
PUPILLA MUSCORUM (Linn.) 3 examples.
CLAUSILIA BIDENTATA (Ström). 3 examples.
CARYCHIUM MINIMUM, Müll. Common.
POMATIAS ELEGANS (Müll.) Common.
ACICULA LINEATA (Drap.) 4 examples.

The band formulæ of HELIX NEMORALIS are:—

1 2 3 4 5 —25 examples.
(1 2 3 4 5)— 5 „
(1 2 3)(4 5)— 3 „
1 2 3(4 5)— 3 „
0 0 0 0 0 — 2 „
1 0 3 4 5 — 1 example.
0 0 3 0 0 — 1 „
0 0 3 4 5 — 1 „

Six examples with the bands coalesced at the mouth were also noted.

The band formulæ of HELIX HORTENSIS are:—

0 0 0 0 0 — 9 examples.
1 2 3 4 5 — 2 „
1(2 3)(4 5)— 1 example.

CENTRE PIT 2, 4 FEET LEVEL FIREPLACE.

VITRINA PELLUCIDA (Müll.) 4 examples.
VITREA CRYSTALLINA (Müll.) Common.
POLITA NITIDULA (Drap.) 3 examples.
„ RADIATULA (Alder). 2 examples.
„ PURA (Alder). 4 examples.
ARION, sp. 5 granules.
PYRAMIDULA ROTUNDATA (Müll.) Common.
HYGROMIA HISPIDA (Linn.) Common.

HELICELLA ITALA (Linn.) 1 example.
ACANTHINULA ACULEATA (Müll.) 3 examples.
VALLONIA COSTATA (Müll.) Common.
„ EXCENTRICA, Sterki. 8 examples.
HELIX NEMORALIS, Linn. Common.
„ HORTENSIS, Müll. 8 examples.
ENA OBSCURA (Müll.) 1 example.
COCHLICOPA LUBRICA (Müll.) 6 examples.
PUPILLA MUSCORUM (Linn.) 8 „
VERTIGO PYGMÆA (Drap.) 1 example.
TRUNCATELLINA MINUTISSIMA (Hart.) 1 example.
CLAUSILIA BIDENTATA (Ström). Common.
CARYCHIUM MINIMUM, Müll. Common.
POMATIAS ELEGANS (Müll.) Common.
ACICULA LINEATA (Drap.) 1 example.

The band formulæ of HELIX NEMORALIS are :—

1 2 3 4 5 — 15 examples.
1 2 3 (4 5)— 3 „
(1 2 3 4 5)— 7 „
0 0 0 0 0 — 1 example.
(1 2 3)(4 5)— 1 „

There were also 5 examples with the bands coalesced at the mouth, as previously described.

The band formulæ of HELIX HORTENSIS are :—

(1 2 3 4 5)— 3 examples.
0 0 0 0 0 — 4 „
1 2 3 4 5 — 1 example.

10 FEET LAYER.

HELIX NEMORALIS, Linn. 2 examples. Band formulæ :—
1 0 3 4 5
(1 2 3 4 5)
HELIX HORTENSIS, Müll. 1 example. Band formula :—
0 0 0 0 0

Shells found with child's jaw 10 ft. below cut edge.

POLITA PURA (Alder). 1 example.
„ RADIATULA (Alder). 1 example.
ARION, sp. 1 granule.
PYRAMIDULA ROTUNDATA (Müll.) 5 examples.
HELICIGONA LAPICIDA (Linn). 7 examples.
ACANTHINULA ACULEATA (Müll.) 1 example.
HELIX NEMORALIS, Linn. 1 example. Band formula :—
0 0 3 0 0
HELIX HORTENSIS, Müll. 2 examples. Band formula :—
(1 2 3 4 5)
CLAUSILIA LAMINATA (Mont.) 2 examples.
CARYCHIUM MINIMUM, Müll. 1 example.

LAYER 5.

HELIX HORTENSIS, Müll. 2 examples.
(1 2 3 4 5)

LAYER 6.

POLITA SYDNEYENSIS (Cox). 1 example.

FLOOR 3.

POLITA RADIATULA (Alder). 1 example.
PYRAMIDULA ROTUNDATA (Müll.) 1 example.
VALLONIA PULCHELLA (Müll.) 1 example.
HELIX NEMORALIS, Linn. 3 examples.
„ HORTENSIS, Müll. 2 examples.
COCHLICOPA LUBRICA (Müll.) 1 example.

The band formulæ of HELIX NEMORALIS are :—

1 2 3 4 5 — 3 examples.

The band formulæ of HELIX HORTENSIS are :—

(1 2 3 4 5)— 1 example.
0 0 0 0 0 — 1 „

SECTION 7.

4 FEET.

POLITA SYDNEYENSIS (Cox). 1 example.
„ NITIDULA (Drap.) 1 example.
ARION, Sp. 1 granule.
HELICELLA ITALA (Linn.) 1 example.
VALLONIA PULCHELLA (Müll.) 2 examples.
„ EXCENTRICA, Sterki. 1 example.
„ COSTATA (Müll.) 5 examples.
HELICIGONA LAPICIDA (Linn.) 1 example.
HELIX NEMORALIS, Linn. Common.

The band formulæ of HELIX NEMORALIS are :—

1 2 3 4 5 — 8 examples.
0 0 0 0 0 — 6 „
(1 2 3 4 5)— 4 „
(1 2) 3 (4 5)— 1 example.
1 2 3 (4 5)— 1 „
0 0 3 4 5 — 1 „

LIP OF CANON GREENWELL'S PIT IN UNDISTURBED CHALKY DEBRIS.

PUNCTUM PYGMÆUM (Drap.) 1 example.
VALLONIA EXCENTRICA, Sterki. 1 example.
HELICIGONA LAPICIDA (Linn). 1 example.
HELIX NEMORALIS, Linn. 10 examples.
PUPILLA MUSCORUM (Linn.) 1 example.
POMATIAS ELEGANS (Müll.) 5 examples.

The band formulæ of HELIX NEMORALIS are :—

1 2 3 4 5 — 3 examples.
(1 2 3 4 5)— 3 „
1 0 3 4 5 — 3 „
1 2 3 (4 5)— 1 example.

CONCLUSIONS.

The shells found in the galleries are so few in number that they are valueless as evidence of age, but those found in the infilling of the pits furnish valuable testimony. As already noted these are mainly contemporary with the flint-mining, but a few belong to an earlier period. All the species are known to occur living in Norfolk, but, as noted by Mr. Mayfield, there are differences between the molluscan fauna found in the pits and the existing one. The former is decidedly a woodland group, many of the species being such as require moisture and shade. Mr. Mayfield carefully collected the Mollusca now living in the immediate vicinity of Grime's Graves, both from the wood and also from the hollows over the filled-up shafts, and found that several of the species, though common in the shaft material, are now apparently absent. He notes—"I am surprised at the number of specimens of *Acicula lineata*, Drap., that occurred (in the shaft material) since it is a rare species in East Anglia. I have never yet taken it alive, and when I noticed its presence I carefully searched for it in the bottoms of the hollows, but found no trace. Indeed, the hollows must be considerably drier now than formerly, for I could not find in them such shells as *Carychium minimum*, Müll., and *Vitrea crystallina* (Müll.), which are abundant with us wherever moisture collects among dead leaves." Both these species are common in the shaft material, and we can cite in addition the presence of two species of *Clausilia*, and especially *Vertigo pusilla* (Müll.), as clearly proving the former damper conditions, whilst the comparative rarity of *Helicella itala* (Linn.), is additional evidence. We can therefore conclude that when flint-mining was being carried on at Grime's Graves the climate was decidedly wetter than it is to-day. We have carefully considered the question as to whether this marked desiccation is the result of the lowering of the underground water level arising from the piercing of the boulder clay by the shafts of the pits. But it appears to us that if this were so the results would be produced by the sinking of two or three shafts, whereas it is clear from the evidence that the damper conditions existed for a long period after the boulder clay was cut through.

As already noted, a number of derivative examples of *Helix nemoralis*, Linn., occurred in the infilling, the relics of an earlier period than the flint-mining one. Nearly all these are decidedly larger than those of the present day, and not a few have a maximum diameter of 25 mm., whereas for recent English examples, 22 mm. would be reckoned a large shell. (Plate XXV.) Some are abnormally heavy, a condition arising probably from age, and indicating that these individuals had been able to hibernate through more than

Plate XXV.

The shells above are contemporary *Helix nemoralis* from the infilling of the pits; those below are derivative *H. nemoralis* also from the infilling.

(Photo by "Prehistoric Society of East Anglia.")

two winters. At the present day it is exceptional for an example of this species in the east and south-east of England to hibernate more than once. The contemporary shells from the infilling agree in every respect with recent examples. We thus see that preceding the damp period, there was one where the conditions were far warmer than they are to-day or were when the flint-mining was being carried on. An absolute parallel to this occurs at Dogs' Bay, Roundstone, Co. Galway. At that place, the lowest bed is of fine blown sand with abundant examples of very large and heavy *H. nemoralis*. This is succeeded by a grey layer containing a damp loving fauna and normal *H. nemoralis*. As regards the position of these periods in geological chronology it is clear that it must be in the Holocene period from the total absence of all characteristic Pleistocene species. It has been suggested that these excavations are of "Cave Age," *i.e.*, late Pleistocene, but the zone fossils of that period are well-known, and are all absent.

Moreover, the pits are certainly later than the boulder-clay, and this, in our opinion, marks the close of the Pleistocene. This opinion may be heretical, but it is the only possible one from palæontological evidence. That the infilling is earlier than Roman times is shewn by the total absence of *Helix aspersa*, Müll., a species which in the east of England was introduced probably in Late Celtic times, and is abundant in Roman deposits. The age of Grime's Graves is thus between the end of the Pleistocene and the Roman period. Prof. F. J. Lewis has clearly shewn from the evidence of the Scotch peat mosses, that the period succeeding the glacial was warmer than the present one. It is characterized by an abundant forest growth, and is succeeded by a much damper period. This early warm period is called by the Scandinavian geologists the "Tapes" period, from the characteristic shell of the marine deposits. In Denmark it is known to be early Neolithic and to coincide with the end of the Fir and beginning of the Oak periods, and the well-known Danish Kitchen Middens belong to this period. In Ireland, it is represented by the "*Thracia convexa*" clays of Belfast, and the raised beaches of Portrush, Larne, etc., with their well-known flint industry. In England, the lower forest bed of the Thames Holocene alluvium is probably of this age, though the peat in which it is preserved may well represent the succeeding damper period.

In our opinion, the two periods represented by the mollusca from Grime's Graves, may be safely correlated with the two periods shown by Prof. Lewis to be early Holocene, and the true age of Grime's Graves is thus the damp period succeeding the warm "Tapes" period.

[The Mollusca are deposited in The British Museum (Natural History); Norwich Museum; Ipswich Museum; Leeds Philosophical Society's Museum; National Museum of Wales, Cardiff; Cambridge Museum of Archæology; Worthing Museum; Salford Museum (Peel Park); Horniman Museum, London, S.E.; and Manchester Museum.]

The Charcoal.

By Clement Reid, F.R.S.

The charcoals consist of oak, beech and pine (*Pinus sylvestris*) in about equal quantity. They may include one or two fragments of hazel, but these are too small and badly preserved for determination. The roots I can make nothing of—they are too much decayed. As is usually the case in chalky rubble, I can find no seeds, except half a carbonised seed of yew from the black band in Pit I. Apparently only carbonised things are preserved.

The occurrence of pine and beech is of interest, as bearing on the date of the change in the forests. In the southern half of England the pine seems to have been exterminated in prehistoric times, though common in the submerged forests. It was apparently re-introduced about 300 years ago. It looks as if this extermination may have been due to forest-fires and the free use of pinewood for firing. In our moist climate the pine is the only tree likely to be affected by forest fires, and its resinous character would make the wood so valuable for fires and torches, that the trees not destroyed by accident or in clearing the ground would quickly be used up.

Beech-leaves were determined by Baron C. von Ettingshausen from the Cromer Forest Bed, but I do not feel satisfied with this determination. I have not seen beech from any British Pleistocene deposit; but a dry-soil tree does not easily find its way into lacustrine or alluvial strata. The earliest certain record I have is during the Roman occupation.

I should expect, judging from the soil, that the neighbourhood of Grime's Graves would be open woodland, probably thin beech, oak and pine; though this is a point that a study of the associated land-snails should settle. This matter, the character of the woodland, is much complicated by the occurrence of forest-fires, which would tend to keep down the pine and beech, and encourage the oak. The oak is not inflammable, but the soil would not suit it so well, and the fragments of oak-charcoal generally suggest poorly-grown trees.

DETAILS.

Pit I.—Centre of pit, 2½ ft.—Beech (*Fagus sylvatica*).
Base of layer 3, 10 ft.—Oak (*Quercus Robur*).
Black band, layer 4.—9 ft. Oak, beech. 10 ft. Pine, twig and charcoal (?) Bark of sallow (?) Pine (*Pinus sylvestris*) and oak. Half a carbonised seed of yew (*Taxus baccata*). Lower 3 ft., beech, small roots.
Layer 5, 12 ft. between chalk blocks.—Roots, indeterminable.

PIT I. *(continued.)*

Fireplace W. of coves in Wallstone—Oak.
Layer 8, 24 ft. between chalk blocks—Beech, oak.
27 ft.—Oak, beech. Parts of large branches, oak and beech.
Layer 9, sandy rubble—Oak and beech (?).
Lowest 3 ft. of pit, between blocks of chalk—Oak and beech.
29 ft., between chalk blocks—Oak.
Gallery I. Between chalk blocks—Oak, beech (?).
Gallery VIII.—Beech.

PIT II.—Layer 2, rubble, 4 ft.—Cone of pine, roots indeterminable.
Layer 3, black band—Large quantity beech and pine and some oak.
Between layers 3 and 5 at N. side close to lip. Indeterminable roots and osiers (?).
Layer 5.—Oak.
Layer 5, 15 ft.—Beech. Small twisted twigs (sallow?) I think that these must belong either to basket-work or to the handle of some implement, the fragments are insufficient to show which.
Layer 6, between blocks—Oak.
10 ft.—Oak, beech (?).
Layer 7—Oak.
6 ft. below top of chalk—Oak.
Gallery II.—Oak.
Gallery VI.—Oak, beech (?).
Gallery VII.—Beech.

Section VII.—Beech.

[The charcoal is preserved at Cambridge Museum of Archæology, Ipswich Museum, and Norwich Museum.]

The Soils.

By Albert Gilligan, B.Sc., F.G.S.

The surface of the ground west and south-west of where the excavations called Grime's Graves have been made, is occupied by a deposit of glacial origin, known as brick earth. This has almost certainly resulted from the continued action of the ordinary weathering agents upon the chalky boulder clay which occurs, spreading over the country to the east, and outlying patches of which are found upon the brick earth. The chalky boulder clay of this neighbourhood contains just those materials, with the addition of chalk, which are found in the brick earth, and it seems clear that decalcification of the chalky boulder clay by percolating water, containing carbon dioxide in solution, would yield the brick earth. An examination of the 1" Geological Map shows this brick earth as an elongated patch, running in a N.E.—S.W. direction for about 2 miles, and having a width, which is greatest in the neighbourhood of Grime's Graves, of about ¼ to ½ mile. The solid rock underlying the brick earth and from which the flint was obtained, is the upper chalk, which, in this district, is soft, and therefore easily worked.

The most noticeable constituent of most of the samples submitted to me is chalk of the type found in the neighbouring country. In all examinations this has been eliminated either by washing with water or treatment with dilute hydrochloric acid. Flint chips also are present in most of the samples; these show a variation in colour from a milky translucent type through various shades of grey to black. In the residues resulting from the washing and treatment with dilute hydrochloric acid the following substances were found:—Clear quartz and some coloured grains (the dominant colour being yellow; pink and opalescent grains are also fairly common), sandstone pebbles, jasper, limonite, and sponge spicules.

The larger quartz grains were in all cases well rounded, while the smaller ones were either angular or sub-angular. In some cases the rounding of the grains is so perfect as to make one think that they must have been originally windborne.

The following is a description of some of the more important layers met with in the shafts and elsewhere:—

No. 1. Base of Layer I., Pit I. (see p. 45).

A brown friable soil with large amount of broken chalk rubble and shell fragments, these being chiefly *Cyclostoma*, and numerous brown grains of limonite and quartz grains.

After treatment with water and dilute hydrochloric acid:—An abundance of perfectly clear quartz grains, the larger ones being

well rounded, while the smaller ones are angular and sub-angular. Grains of limonite, showing a high polish, flint fragments in small numbers, and a few pieces of sandstone.

No. 6. Layer 3b., Pit I., Boulder Clay till or wash (see p. 46).

The sample looks like broken chalky material, but the microscope shews an abundance of quartz as well as grains of limonite.

After treatment:—Perfectly clear quartz, the larger grains being well rounded, and the smaller ones angular and sub-angular. Milky quartz fragments and some coloured, yellow and brown. A few larger pebbles of sandstone and a few bits of jasper and flint. A fragment of what appeared to be simply chalk, when acted upon by hydrochloric acid, was found to contain the same materials as those named above.

No. 30. Undisturbed Chalky Boulder Clay from Section 7 (see p. 115).

Appears to be more friable than No. 6 and contains more oxide of iron. Quartz and flint are well seen under the microscope.

After treatment:—The same as No. 6, except that the flint fragments are somewhat more plentiful and the sandstone absent.

No. 14. Boulder Clay, 10 ft. below lip of chalk, Pit I., E. face covering chalk. (See p. 39.)

Shells and shell fragments in fair quantity, including two specimens of *Zonites glaber*. The microscope shows quartz, limonite, and flint.

After treatment:—This contains the same materials as Nos. 6 and 30, and could not be differentiated from them.

No. 32. From interment 10 ft. deep in tumulus. (See p. 109.)

The sample is made up of fragments of chalk, chalky boulder clay, flint, with a fair quantity of quartz sand. Some very small fragments of woody material, too small for identification.

After treatment:—Quartz grains of the usual type make up most of the residue, differing in colour—yellow, red, and opalescent being abundant, but the bulk of them are perfectly clear. Flint chips present, and carbonaceous material, which is in some cases charcoal, as the structure can be seen.

No. 33. Sand (containing charcoal), 10 ft. deep, in centre of tumulus. Upon this lay a floor of black chipped flints. (See p. 109.)

A reddish quartz sand with many small fragments of flint. Charcoal present, also small fragments of chalk and limonite.

After treatment:—The quartz grains show a dominant pink tinge, the larger ones being rounded. The small grains are generally clear and angular. The flint fragments are in some cases of a reddish colour, while jasper is also present. Charcoal makes up a fair proportion of the residue.

No. 36. Sand 3¼ ft. below present level, Section 8 (see p. 119). This sand forms a dark band with reddish sand above and below—probably an occupation level.

This appears to be very similar to No. 33, but the sand grains are on the whole smaller, and the flint fragments larger. The microscopic examinations confirm this.

No. 10. Black band, S. side of Pit 1, 8 ft. from E. edge. (See p. 47).

Weight of sample 77·73 grams. After treatment with hydrochloric acid the residue was ignited. Loss on ignition (organic matter) = 0·8 grams. Therefore percentage of organic matter in original sample was about 1·0 %.

Cyclostoma elegans, *Zonites glaber*, *Helix* sp. (*? nemoralis*) and *Clausilia rugosa* occurred in eight of the forty-four soil samples submitted.

By Henry Dewey, F.G.S.

Samples of undisturbed sand and of undisturbed chalky boulder clay from the side of Pit I. (see Fig. 2, p. 44) were submitted to Mr. H. Dewey, F.G.S., who reported as follows:—

"An ounce of the sand was treated with strong hydrochloric acid, but there was only a small quantity of CO_2 evolved, and no more after raising the acid to boiling point. Washed and fine mud poured off. Coarse residue filtered and dried. It weighed $\frac{6}{10}$ ounce. This sand is rather fine grained, well water-worn and consists of quartz and a subordinate amount of tourmaline. The coarser grains are mainly chips of flint up to $\frac{1}{8}$ inch in diameter.

"The Boulder Clay.—An ounce treated with strong hydrochloric acid evolved volumes of CO_2. Residue washed, filtered, dried and weighed ($\frac{1}{10}$ ounce). It consists also of well water-worn grains of quartz with chips of flint and a minute quantity of heavy minerals such as zircon and tourmaline. The original clay contained $\frac{4}{5}$ ounce of chalk ($Ca\,CO_3$), which was removed by the HCl. and left a residue strictly comparable with the sand which overlies the clay. There is therefore no reason why the sand was not derived from the chalky boulder clay by atmospheric leaching and solution of the lime."

The Swedish Flint-Mines.

By NILS OLOF HOLST,* Ph.D.

(Late of the Geological Survey of Sweden.)

The prehistoric flint-mines of Sweden were discovered in 1903. They are situated in the southernmost part of that country, a few miles east of the town of Malmö, in three villages, Kvarnby, Sallerup, and Tullstorp. They are sunk in the white chalk, which has been worked here for half a century in ten separate chalk-pits, and has of late been used on a large scale both at home and abroad. It is, however, only in four of these chalk-pits that flint-mines have been found, though traces of flint-miners are to be seen in all the pits except one. The distance between the two most remote pits is about two English miles.

The most remarkable point about the occurrence of this chalk is that it is not *in situ*, as geologists in general supposed it to be till quite recently, but consists only of loose blocks of various sizes brought by the inland ice from the Baltic and deposited between the two moraines—the ground moraine and the upper, usually fairly thin, surface moraine. Owing to the economic value of the chalk, several borings have been made through it, so that the mode of its occurrence is clearly ascertained. Of these blocks three or four are very large, and the largest appears to have a length of about 3000 feet, a breadth of about half that, and a thickness reaching from 10 to 20 feet. On this remarkable occurrence, which can be paralleled also on the German side of the Baltic, I have written more fully in a separate paper, to which I may here refer.†

Originally the flints lay in this chalk, stretched like beads on a string in horizontal layers, but now they have been raised and disturbed by the inland ice, though as a rule less than one might expect. They are often cracked, but by no means always, and, especially in the upper beds, they may be quite uninjured. The flint is dark, often quite black, and has a very regular fracture which adapted it remarkably well to the use for which it was employed in prehistoric times. That it then formed, probably after being worked up to some extent, an important article of commerce may be inferred from the fact that flint implements are now to be

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* At the request of Mr. W. G. Clarke, Hon. Secretary of the Prehistoric Society of East Anglia, the Author has drawn up this abstract of his work, "Flintgrufvor och Flintgräfvare i Tullstorpstrakten" (Ymer, 1906, pp. 139-174). To some extent he has also drawn upon another work "Förhistorisk grufbrytning i Sverige," a lecture printed at Örebro in 1912, and delivered before Bergshandteringens Vänner in that town.

† Om skrifkritan i Tullstorpstrakten och de båda moräner, i hvilka den är inbäddad. Sveriges Geol. Undersökning, Serien C., No. 194, Stockholm, 1903. More or less complete abstracts of this article are to be found in Geologisches Zentralblatt, 1903, Geological Magazine and American Geologist for February, 1904, as well as in Bulletin de la Société Belge de Géologie.

found all the way along the eastern coast of Sweden far up to the north, while the flint itself, with the chalk in which it occurs, is restricted to the most southern parts of the country.

THE SHAFTS.

The flint was won by sinking a fairly regular shaft, about 7 ft. in diameter, occasionally somewhat oval, down through the surface covering of drift (usually the surface moraine) which as a rule is only from 1 to 7 ft. thick, and continuing through the chalk till, at a depth of 3 to 10 ft., the uppermost flint layer was reached. Then as much flint was taken out as could be got at by horizontal workings round about the shaft. The loose condition of the chalk, due to shattering by inland ice, usually prevented these workings from becoming more than a small vault round the shaft; and from their resemblance to "baker's ovens" these vaults have received that name from the present quarrymen. On the horizontal floor of one of these vaults there have been found the remains of a carbonised pit-prop, identified as birch by Baron Cl. Kurck.

Sometimes the shafts lie very close together, and two adjacent shafts may actually be in connection up to the upper surface of the chalk. I was able to count sixteen shafts on a rectangular area of chalk, 93 ft. by 17 ft. The loose and shattered condition of the chalk must have rendered timbering the shaft particularly desirable. Evidence of this may perhaps be found in the so-called "stake holes," open holes of the thickness of an arm or less (1 to 3 inches in diameter) which enter the chalk in a vertical or slanting or sometimes horizontal direction. They are always straight, or nearly so, and are said sometimes to go up to the surface of the chalk but never to continue below the floor of the shaft. Such a hole is said to have been followed to a length of 14 ft., and in some of them charcoal has been found.

As soon as the workings were finished, each shaft was filled up again, partly with earth and with the chalk thrown out of it, partly also with fragments of flint which are often an important constituent of the filling. The white chalk in this filling causes the shaft to stand out boldly against the drift covering as it passes through it. The workmen therefore call these shafts "chalk pillars."

It is well known that flint newly taken from the chalk is, probably on account of its moisture, more easily worked than flint which has lain a long time in the air. This seems to have been the reason why the coarser working of the flint brought up from the shaft was carried on close beside it; and thus it is that we find lying there, not only the refuse splinters proper, but also such roughly blocked out cores as were found in the progress of the work to be full of cracks or of holes, or for some other reason difficult or impossible to work, and which therefore were thrown away.

To have the sharp, cutting flint scraps lying round the shaft on ground over which they had to pass each day must have been very unpleasant for the miners, especially if they were barefooted. It

was probably this that induced them to rid themselves of the scraps by throwing them down into the shafts, which had to be filled somehow or other.

Among the flint rubbish there has not been found a single complete implement showing a finished working of the flint. The finishing seems to have been done in another place.

As appears from the preceding, the shafts of the Swedish flint-mines are not very deep. The mining works themselves therefore are not comparable in importance with those carried out in England and Belgium. On the other hand, the shafts are proportionately more numerous.

Flint-mines have also been found in France, Portugal, Italy, and North America. The mining industry was of especial importance in Belgium, as has been more and more recognised of late years. On the other hand, it is remarkable that in Denmark, extraordinarily rich as it is in Neolithic flint implements, no flint-mines have yet been discovered. However, the Danish archæologists remain convinced that flint-mines did exist and will sooner or later be detected.

STAGS-HORN PICKS.

The commonest tool of the flint-miners was the pick of stags-horn, and this is the commonest of all finds in the flint-mines. Their frequent occurrence also in other countries has led Greenwell and others to remark that the stag must have been a very common animal in prehistoric times. Nevertheless, the supply of such picks does not seem to have been sufficient for the great flint-mine industry in Belgium, and consequently picks of flint were used there in great numbers, as sufficiently proved by older finds and those of recent date.

In Sweden, however, flint picks have not yet been found, but there, so far as is known, only stags-horn picks were used. Such were formed in the simplest possible way by sawing off the horn so that only two tines or a tine and a portion of the beam remained. Then, one of the tines was used as a pick point, and the other on the beam as the handle. These tines are therefore, as a rule, much cut and polished at their ends.

There were also used picks of horn from which the tines had been entirely removed, while in their place were inset so-called "teeth" of flint. Horn picks of these two kinds, and other fragments of horn found in the flint-mines and chalk-pits are shown in Plate XXVI.

That accomplished osteologist, Inspector H. Winge, of the Zoological Museum in Copenhagen, was the first to perceive that the stags-horn fragments from the Swedish flint-mines are "Stone Age implements" or handles for such.* Concerning the handle

*Such implements from the flint-mines have been in the Zoological Museum at Lund University since 1866, but it was nearly half-a-century later that their meaning thus became known through the observation of Winge.

shown in Plate XXVIA he has written as follows:—"This is the lower part of a thick horn fashioned into a pick; traces of tool-marks show that the brow and bez tines had been artificially removed and in their place had been bored two holes, in which teeth were certainly stuck; at the lowest end the horn fragment is truncated by grinding; the boss is wholly ground away."

Of the horn fragments shown in Plate XXVIB, *e* and *f* are ordinary horn picks with both tines much worn; *a* is a less usual form, in which the lower tine is somewhat worn; *h* and *i*, the latter being broken off, were possibly used in the same way. They are, however, like the "slagstokke" of the Danes, which were used in quite a different way.* *c* is a handle. *d* and *g* are pieces of horn remaining after the tines have been cut away. Winge describes the latter thus:—"Cut off upper end of a horn with 'prong.' Two tines are cut away. Tool-marks are everywhere fairly clear, in the usual style of the Stone Age. The fragment is not actually a tool but a remnant of horn from which tools have been made." It should, however, be mentioned that *d* and *g* also are somewhat worn. Fragment *l* was probably used as a hammer. When the cut off ends of the horn are hollowed they seem to have served as a fixing for a pounding tool. This is the case with *j*, *o*, both ends of *a*, and the cut off end of the pick-handle in Plate XXVIA.

Horn fragments corresponding to those represented in *e*, *f*, *h*, *i*, and *l* are known from flint-mines on the Continent. These provoke the inquiry: Is this a migrating civilisation which one land gave to another, or did the same need call forth independent discoveries in different places?

A POTTERY LAMP.

In one of the shafts a remarkable find was made, namely, a lamp of pottery (Plate XXVII.), which lay at a depth of 9 feet in the shaft. The whole shaft, however, was only 13 feet deep. Therefore there was no need of any lamp during the day-time, but it must have been used either before dawn or after sunset. This, so far as it goes, is evidence of the energy with which the flint industry was pursued in this district. The lamp seems too well made to belong to the Stone Age. This then confirms what is gathered from other finds described below, namely, that the flint industry in this district continued after the conclusion of the Stone Age.

THE DWELLING-PLACES.

Richer in articles of human workmanship and therefore in some respects more interesting than the shafts, are the dwelling-places which are found close to the flint-mines, and to which in the southernmost province of Sweden there is nothing else to correspond. Two *large* dwelling-places have been found, namely, one which may

* See A. P. Madsen, S. Müller, etc.: Affaldsdynger fra Stenalderen i Danmark, p. 68. Kjöbenhavn, 1900.

Plate XXVI.

A.—Lower end of stag's antler with two holes in which flint teeth were fastened—probably the handle of a pick. $\frac{1}{3}$.

B.—Antler fragments from seven different chalk pits, the majority used as picks or pick-handles. $\frac{1}{6}$.

a

b

Lamp of clay (*a*) from the side; (*b*) from above. Natural size.

be regarded as having belonged to a prehistoric village community and therefore has been called Flintby (Flint-village), probably dating from the latter part of the *Neolithic Age*, and a smaller one, which obviously was inhabited during the *Early Iron Age*. Further, there has been found a couple of *smaller* dwelling-places, each probably for a single family, which, at least in part, date from the *Bronze Age*, as well as a fairly large number which are *only from 3 to 4 feet* in diameter. These latter seem only to have been used occasionally. Swedish archæologists are accustomed to call them *hearth hollows*.

The sign of such dwelling-places is the "black earth"—the so-called "culture-layer." A sample of this earth has been analysed and shown to contain only 2 per cent. of organic matter (including the water in chemical combination), or much less than its dark colour gave one to suspect. From this it may be concluded that the colour is mainly derived from the finely powdered charcoal which was thrown out from the ancient fire-places. Small bits of charcoal are also a constant but variable constituent of the "black earth."

The culture-layer contains, besides charcoal, the following objects which seem to have been used by the prehistoric inhabitants and lie strewn around in variable quantities in the layer, namely:—

1. *Fire-cracked stones* from the ancient hearths.
2. *Flint flakes* (Plate XXVIII. *e-e*), as well as *flint rubbish*, but only very rarely a more or less complete *flint implement* (Plate XXVIII. *b* and *c* and Plate XXIX.).
3. Larger or smaller fragments of the *bones of domesticated* and *wild animals*, the latter very rare; as a rule the remains of meals.
4. *Pottery*. Pieces of broken pots without ornament, and small rounded lumps of burnt clay, which are very numerous.*

Further, in dwelling-places of the *Early Iron Age* there has been found the so-called *harpix* (a kind of resin).

THE FLINT VILLAGE OF THE NEOLITHIC AGE—FLINTBY.

This dwelling-place—the largest of all—is now half destroyed by the quarrymen, but formerly it occupied an area of more than 20,000 square feet. When it is observed that the culture-layer at but a short distance from the edge of the dwelling place has reached a thickness of 5 ft., and further in from the edge may exceed 7 ft., then it is clear that the site must have been inhabited for a fairly long time by quite a large population, probably of flint-miners.

Comparison of this dwelling-place with the one of the Early Iron Age described further on, shows that the culture-layer in Flintby is lighter in colour, and more weathered, as well as remarkably hard

* Dr. Sophus Müller tells me that similar lumps of clay have also been observed in some of the Danish prehistoric dwelling-places.

and well trodden down probably during the constant traffic between the dwelling-place and the workplace, that is to say, the flint-mine.

The culture-layer is covered by ordinary humus about one-and-a-half foot thick, in which splinters of flint are the only objects that betray human activity. But immediately under the humus, in the culture-layer itself, one finds the burnt lumps of clay mentioned above and small clay-balls, the size of which varies between one-sixth of an inch and one inch in diameter. With these are also found small fragments of clay pots. The lumps of clay seem to be most numerous at a depth of a couple of feet. Deeper down come much weathered fragments of bones of ox, sheep, and pig; but these are not nearly so numerous as those from the dwelling-places of the Early Iron Age. Deep down are also found charcoal, flint-rubbish, and fire-cracked stones.

Some flint objects from the culture-layer are represented in Plate XXIX.* The flint ball or hammer-stone above on the right has already been represented in Plate XXVIII. *d*. Beside it is an ordinary Neolithic end-scraper, 91 mm. (3·6 in.) long, found at a depth of 1·3 metres (4·4 ft.), a fire-striker, and a tranchet. Besides these, more recent diggings have brought to light six other end-scrapers, five flint borers, and one fire-striker.

All these flint implements, the hardness and aged appearance of the culture-layer, and the relative paucity of bones of domestic animals, indicate that the dwelling-place belonged to the Neolithic Age and probably to its later period. The size of the dwelling-place and its immediate proximity to the shafts of numerous flint-mines make it most probable that it was inhabited by the miners, who probably were in the condition of slaves.

At a distance of only some 10 feet from the large dwelling-place just described, there have been found two smaller ones, probably of single families. One of these may here be briefly described. It was 12½ feet in diameter and had two hearth-hollows about two feet deep, immediately opposite one another on the outer margin. The culture-layer between the hearth-hollows lay beneath the humus, and it was clear that the dwelling-place had from the beginning been excavated a couple of feet below the level of the ground.

In the culture-layer there were found the usual objects: flint flakes and flint rubbish, charcoal, various fire-cracked stones, pieces of clay pots, as well as a beaver tooth. On the inner surface of one of the potsherds was closely attached a carbonised substance which probably represents the remains of meat (? carbonised blood). Since the potsherds resemble those which archæologists refer to the Bronze Age, this dwelling-place has been referred to the same period.

Be the age of the potsherds what it may, it is at any rate certain that the mine district was inhabited, and was probably being worked during the Bronze Age. A young archæologist (now a University Lecturer), Bror Schnittger, who carefully examined one

* "Förhistorisk grufbrytning i Sverige," 1912, *cf.* footnote 1.

Plate XXVIII.

Top Row—(*a*) Flint core, said to come from a depth of 5 feet. (*b*) Worked flint from dwelling-place of the Early Iron age. (*c*) Tranchet, from a shaft. (*d*) Hammerstone from the "black earth" of Flintby.

Second Row—(*e-e*) Flint flakes from dwelling-place of the Early Iron age.

Third Row—(*f-f*) Slingstones (?) from the same dwelling-place.

Fourth Row—(*g-g*) Sandstone plates from the same dwelling-place. $\frac{1}{3}$.

Plate XXIX.

Implements from Flintby.

Scraper.
Fire-striker.
Hammerstone.
Tranchet. $\frac{2}{3}$.

of these smaller dwelling-places,* situated some way from that described above, but in the neighbourhood of other flint-mines, has established the fact that the *lower* part of the dwelling-place belongs to *the end of the Neolithic Age*, while the *upper* part is formed of a *Bronze Age* deposit with numerous flints.

DWELLING-PLACE OF THE EARLY IRON AGE.

This dwelling-place, though smaller than that of Flintby, is still of considerable size; about 100 feet from east to west. The northern part has been quarried away. The culture-layer, which attains a maximum thickness of about 5 ft., has yielded many objects which show that the inhabitants had reached a higher degree of civilisation than those who lived in the dwelling-places previously described.

A section, taken where the dwelling-place is most complete has the following appearance:—Tippings of the quarrymen 1·5 ft.; black earth (culture layer) 3·7 ft.; alluvial clay with shells, ·1 ft.; peat (this is also a culture-layer) ·5—·8 ft.; chalk rubbish and chalk. *Flint-flakes* and *flint rubbish* are distributed through the whole of the black earth up to its very surface, abundantly below, but somewhat less abundantly above. This flint rubbish occurs in such quantities that it cannot have been mixed in the culture-layer by mere chance. The flint flakes (Plate XXVIII. *e*—*e*) are somewhat stouter than those which belong to the Stone Age.

The *pottery* in the culture-layers consists partly of the clay lumps previously mentioned, partly of potsherds. The former are more rounded, of finer grain, and perhaps somewhat less numerous than those found in the black earth of Flintby. The potsherds have partly a more indefinite grey colour, partly the natural beautiful rust-red of the burnt clay, and partly a pure deep black, clearly produced by painting the surface before firing with lamp-black or some colouring matter that was carbonised in the firing, such as blood, or resin and oil. Sometimes the outer surface is rust-red and the inner black. The pots were quite well fashioned, and *cannot be older than the Early Iron Age.*

The bones of domesticated animals indicate the same date.† Here too it should be mentioned that, in the early seventies, there was found near this dwelling-place a lump of iron of primitive manufacture (an "Osmund-klump") weighing 2·6 kilogrammes (5 lbs.). This lump, which is preserved in the Mineralogical Museum of Lund University is said to have been found "in the chalk," but it can only have got there in connection with the digging for flint.

The abundance of flint-flakes and flint-rubbish in a culture-layer of this later period shows, however, that during the Early Iron Age in southernmost Sweden no inconsiderable use was made

* Bror Schnittger: Förhistoriska flintgrufvor och kultur-lager. Gradual-disputation, Stockholm, 1910.

† This is fully confirmed by the objects found in the subsequent excavations of Schnittger, such as a food-strainer of burnt clay.

of flint, though what that use precisely was we cannot say at present.

This result, although it seemed unquestionable to the author, has been doubted by Swedish archæologists. It is therefore with great satisfaction that I find it strengthened by observations made in England. Mr. Stevens, the Assistant Curator of the Salisbury Museum, tells me that he has found evidence showing that flint was still used in England as late as Roman times; it was probably then in occasional use, as for knives, and perhaps scrapers. In the Museum at Salisbury there are flints pierced by Roman iron nails. In 1874, Mr. Boyd Dawkins, in his "Cave Hunting" (p. 126), records an examination of a Roman coffin, which pointed to a similar conclusion: the use of flint in England until Roman times.

Besides the objects already alluded to, the black earth has yielded the following finds:—The above-mentioned *rounded pebbles* (sling-stones), Plate XXVIII. *f—f*; *sandstone plates*, Plate XXVIII. *g—g*; and three small pieces of *harpix*. The last-mentioned burns with a sooty smoke and is usually regarded as a mixture of birch resin and wax.*

The section previously given (p. 247), shows that underneath the black earth comes ·1 foot of alluvial clay with shells. In this have been found eighteen different species of molluscs.† It is quite free from objects of human workmanship, although such are found not only in the underlying black earth, but also in the underlying peat. The shell-clay therefore indicates a slight break between the formation of these two culture-layers.

Beneath the shell-clay comes a little peat layer, which may exceptionally reach a thickness of ·8 foot, but is usually only ·5 foot, and occasionally only ·1 foot thick. The peat is impure, gravelly, and much trampled. It contains much flint rubbish, which, however, resembles neither that of the Stone Age nor that found in the overlying black earth, but consists of exceedingly small flakes. There are also found in this peat fragments of charcoal, with bones of domesticated animals, namely, pig, sheep, and ox. No others have yet been observed. According to Winge, the pig was large but the sheep small. The ox-bones are gnawed by dogs.

* Compare C. E. Herbst: Om de over en Kjaerne af braendt Leer stöbte Bronce-Öxer. Aarböger for nordisk Oldkyndighed og Historie, 1866, p. 130. Chr. Hostmann: Der Urnenfriedhof bei Darzau, p. 119. Braunschweig, 1874. Heintzel: Urnenharz aus dem Urnenfelde von Borstel bei Stendal. Zeitschr. f. Ethnologie, XIII. (1881), p. 241.

† (The mollusca noted in the shell-clay and identified by A. C. Johansen. They have been compared by us with those from Grime's Graves and here rearranged. They were—*Polita radiatula* (Ald.); *Punctum pygmæum* (Drap.); *Vallonia pulchella* (Müll.); *Cochlicopa lubrica* (Müll.); *Pupilla muscorum* (Linn.); *Vertigo antivertigo* (Drap.); *Vertigo pygmæa* (Drap.); *Vertigo angustior* (Jeff.); *Carychium minimum* (Müll.); *Succinea elegans* (Risso); *Aplexa hypnorum* (Linn.); *Limnæa peregra* (Müll.); *Limnæa palustris* (Müll.); *Limnæa truncatula* (Müll.); *Planorbis lævis* (Ald.); *Planorbis spirorbis* (Linn.); *Valvata cristata* (Müll.); *Pisidium*, sp. Nine of these species are aquatic and indicate very different conditions from those at Grime's Graves.—A.S.K. and B.B.W.).

Remains of bones are much rarer in the peat than in the black earth.

Among the finds in the peat should particularly be mentioned pieces of linden bast. These have only been found at the bottom of the deposit, and are, as a rule, small and short, sometimes sharply cut across. They are probably remnants from the manufacture of bast cord, which presumably was much used since it served to fasten the domesticated animals. The bast is brownish yellow, but this perhaps is only due to colouring matter in the peat. Professors F. W. C. Areschoug and B. Jönsson have both examined this substance and were the first to make known its true nature. The latter writes:—"Microscopic examination has shown that the golden yellow or brown yellow coloured streaks are composed of bast fibres and newly formed wood tissues. Maceration and chemical treatment proved the presence of cell elements coming from the linden (lime-tree). Particularly characteristic are the portions of vessels provided with both spirals and pits, which must undoubtedly be regarded as belonging to the linden. I consider therefore that the organic streaks may be interpreted as remains of linden bast, with accompanying portions of the newly formed wood tissues."

The basin in the peat was certainly made by man, probably in order to have a water-supply for himself and his animals.

THE HEARTH-HOLLOWS.

Naturally hollows for hearths are also found in the more permanent dwelling-places, but of the more temporary resting-places they are often the only relics. It is only the latter hearth-hollows that are here in question.

They are found in abundance round mine-shafts, but cannot be considered as exclusively pertaining to the mining districts. They are bowl-or funnel-shaped, about three feet wide above, and narrower below, with a depth of from two to three feet, and much resemble one another in size and shape.

In one of them, which was investigated by J. E. Strandmark, the culture earth contained numerous large stones partly fire-cracked, remains of charcoal, flint-rubbish, among which were some fine thin flint-flakes, potsherds, and bones of ox (a small race), sheep, and pig. Remains of the last-mentioned species comprise the shoulder blade of a smaller race (domesticated) and the lower jaw of a larger (wild boar?). The appearance of the potsherds suggests the Iron Age as their date.

DOMESTICATED ANIMALS DURING THE EARLY IRON AGE.

At the dwelling-place of the Early Iron Age have been found the bones of domestic animals in great number, and the quarrymen say that they have carried away very many cubic feet. They are the

remains of the meals of the former inhabitants. The hollow bones are cloven or at least cracked to extract the marrow. The bone fragments are most numerous near the bottom of the culture-layer. Nearer the surface of the ground they are altogether mouldered away. The dwelling-place gives the impression that the inhabitants were quite well-to-do; perhaps the profits from the flint-mines contributed to this.

The bones belong to sheep, ox, pig, horse, and dog, but only the first three of these were at all numerous.* There has also been found a single human bone (a piece of humerus), as well as half the lower jaw of a water vole (*Arvicola amphibius*, Linn.), but this last may have got into the layer at a later date.

In considering the racial peculiarities shown by the domestic animals the author has had the advantage of consulting Inspector H. Winge and Professor E. Lönnberg, both men of great experience in mammalian osteology. The following account is therefore based mainly on their conclusions.

"The *sheep* bones belong to a small race" (Lönnberg).

"All the remains of *cattle* indicate a small and stunted race" (Lönnberg).

How stunted this race was appears from the little horn-core figured (Plate XXXA) which shows on both sides the deep cut by which the horny covering was separated from the core.

"*Pig*.—Fragment of lower jaw,† with both posterior premolars (p 3, p 4) and both anterior molars (m 1, m 2). The length of these teeth is p 3=13·5, p 4=14·5, m 1=16·5, and m 2=22·5 mm. These measurements precisely correspond with those in the sow of a wild pig, and therefore indicate that the jaw-fragment in question belonged to such an animal or perhaps to a tame sow which had not degenerated from its wild ancestry. In confirmation of this, it may be mentioned that the length of the corresponding teeth in an "acorn pig" from Scania, with a shoulder-height of about 80 cm. (31·5 in.), that is to say a large and strong animal, is: p 3=12, p 4=13, m 1=14, and m 2=19 mm.

"The united length of m 1 and m 2 in the jaw-fragment in question is 39 mm. In comparison with this it may be mentioned that according to Rutimeyer the corresponding teeth in a male 'Torfschwein' measure together 37 mm. and in a female 34 to 37 mm., but according to Studer, in a male 'Torfschwein,' 33 mm.

* The mammalian bones hitherto investigated have not been sufficiently numerous to enable one to calculate their relative numbers with certainty. Such a calculation has, however, been made with reference to Björkö (Birka), which was the capital of Sweden during the Viking period, and was at the height of its prosperity from about 800 to 1000 A.D., but is now completely desolate. The culture-layer is about 5 feet thick and stretches over about 16 English acres. It took about 200 years to form, and in it there have been found the remains of domestic animals, which may be arranged in the following order according to their numbers: the commonest is the ox, then come pig, sheep, goat, dog, horse, and lastly cat. H. Stolpe: Naturhistoriska och arkeologiska undersökningar på Björkö i Mälaren. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandl. 1872, No. 1, p. 90.

† This lower jaw as well as one of the shoulder-blades comes from the above-described hearth-hollow of the Iron Age.

The pig from which this jaw-fragment came must therefore have been larger than a 'Torfschwein,' and this fact renders it most probable that we have to do with a fragment of a wild pig.

"Of pigs there also occur two fragments of the shoulder blade. Both of these belonged to a very small animal. This is inferred from the fact that the column scapula in the largest example does not measure more than 25 mm. (1 in.) across at the narrowest place, while the Scanian pig with which comparison is made above has a breadth of 33 mm. at the corresponding place" (Lönnberg).

The fragment of shoulder-blade described by Lönnberg has also a purely archæological interest. It was used as a spoon for food. On this, as on another smaller shoulder-blade, it is very clearly seen how the handle, that is to say the tract just about the neck of the shoulder-blade, is remarkably worn, just as far as the fingers reached when the spoon was used. Winge was the first to draw attention to this use of the pig's shoulder-blade and to show that "spoons of this peculiar character were in very general use in the earlier part of the Neolithic Age."* How long afterwards this use of shoulder-blade spoons continued is for the present not known.

The *horse* bones have been subjected by Winge and myself to comparison with the corresponding bones in a horse skeleton from one of the well known peat-bog finds, namely, in Nydams mosse, which dates from the end of the fourth century A.D. The correspondence was as complete as possible. The race is a small one.†

Lönnberg, who came to the same conclusions, based them upon the following measurements: "The bones are more slender than the corresponding ones of the skeleton of a modern Swedish horse, with a height over the withers of only 145 cm. (14·2 hands). The front part of the lower jaw of a horse (stallion), with well-developed canines, has at the narrowest part of the symphysis a cross diameter of only 30 mm., and in the above-mentioned Swedish horse the same measurement is 35 mm. A fragment of a hind cannon bone does not measure more than 27 mm. in cross diameter, but in the skeleton referred to the same measurement is 33 mm. In the same way the distance from the outer side of the outer trochlear ridge to the inner side of the inner ridge of an astragalus is about 38 mm., but in the modern horse under comparison about 41 mm."

That the *dog* was not rare may be inferred from the fact that the mammalian bones in general as well as the above-mentioned human arm-bone are gnawed by dogs. Among the collected bone

* A. P. Madsen, S. Müller, etc.: Affaldsdynger fra Stenalderen i Danmark, p. 155. Kjöbenhavn, 1900

† In Denmark the following conclusions have been reached with reference to the general development of the races of domesticated animals. The *horse*, which was first introduced during the Bronze Age or at the earliest at the close of the Neolithic Age, was small, not only during the Bronze and Early Iron Ages but also down to the Middle Ages. The *dog* was smaller in the Neolithic Age than later, whereas the *ox* and the *pig* had a contrary development, and from the Neolithic Age, when they were first introduced, became gradually smaller down to the Middle Ages. Compare V. Nordmann: Danmarks Pattedyr i Fortiden, p. 96 et seq. Kjöbenhavn, 1905.

Plate XXX.

A.—Horn-core of a stunted race of Oxen, seen from two sides. From the "black earth" in the dwelling-place of the Early Iron Age. $\frac{1}{3}$.

B.—Skull of a Dog, from the side and from above. From near the bottom of the "black earth" in the Early Iron Age Age dwelling-place. $\frac{1}{3}$.

remains, the dog is represented by a particularly fine and quite complete skull, which is of great interest owing to its strongly marked characteristic shape. During its life-time the animal received a strong cut or blow slantwise across the nose, but this healed and led to no deformation of the cranium. (Plate XXXB.)

"The dog is of a large powerful race, much larger than that which is usual in our Stone Age. On the other hand, it agrees well with our large race from the Iron Age. The length of the skull is about 190 mm. (7·5 in.). The length of the upper canine, 22 mm., and of the upper front premolar 14⅓ mm." (Winge.)

"The most peculiar feature in the general appearance of this skull is the short nose and the profile-contour sloping straight down from the forehead without showing any strong concavity such as is seen in the wolf, still less like that in many of our tame races of dogs. This straight profile and the shortness of the nose conferred on this cranium somewhat the aspect of a *Cuon* (compare Plate XXXB). The remarkably broad and flat forehead is also extremely characteristic, as well as a departure from the usual dog type. This arises from the fact, among others, that the cranium has an interorbital breadth in front quite as large as has a cranium of the Greenland dog, with a basi-cranial length more than 2 cm. (·8 in.) greater." (Lönnberg.)

The dwelling-places herein described are only a portion of those which have been found in the neighbourhood of the old flint-mines. Many are already completely destroyed, and since, as a rule, they only become known as they are uncovered by the quarry-men, it may be taken for granted that there are many still entirely unknown. A similar dwelling-place has recently been found in a more easterly tract of Sweden's southernmost province, near a home-stead called Ulricelund, and it seems probable that this dwelling-place was also connected with flint-mines. Chalk occurs in the neighbour-hood at no great depth.

The Swedish flint-mines that have here been described appear to have been worked, with or without a break, from the later portion of the Neolithic Age down to the Early Iron Age. Did such a mining activity extend further back in any other country, whether in Europe or elsewhere? In other words, during which archæological period did it first begin? The question is of great interest, and it may perhaps be possible to answer it with more or less completeness from examination of the material that has already been obtained.

Grime's Graves Fund.

BALANCE SHEET from October 8th, 1913, to June 21st, 1915.

RECEIPTS.

	£	s.	d.
Donations (see List on pages 8, 9)	225	5	6
Dublin University Museum (per Professor L. White King, C.S.I., LL.D., F.S.A.) ...	4	4	0
Interest	1	15	2
Balance due to Treasurer	16	16	7½
	£247	19	3½

EXPENDITURE.

	£	s.	d.
S. Holden & Son, excavating and fencing two shafts, providing hut, digging sections ...	87	12	4
Ditto, carting and packing	4	15	1
Boxes and nails	7	2	1
Dr. A. E. Peake, hotel expenses	21	10	0
A. L. Armstrong, rail fare	2	2	0
Hon. Secretary, rail fares	4	9	7½
Gratuities to labourers, etc.	1	17	6
Labourer, packing specimens	0	8	0
Carriage	0	12	2
A. S. Kennard, F.G.S., postages mollusca ...	0	2	9
Printing and Stationery	2	5	6
E. J. Lambert, drawing implements and pottery ...	18	3	0
Photographs	1	17	0
T. B. Browne, Ltd., half-tone and line blocks ...	23	13	2
Dr. F. A. Bather, translating Dr. Holst's paper ...	2	5	0
A. E. Soman & Co., printing 500 copies Report on the Excavations	64	8	3
Postages (1066 letters)	4	10	9
Miscellaneous	0	5	1
	£247	19	3½

Examined and found correct, June 21st, 1915.

H. W. COCKRILL,
H. J. THOULESS, } *Auditors.*

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